OPEN FILE REPORT

Manitoba Radiocarbon Dates

By
R.E. Morlan,
R. McNeely
and E. Nielsen

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Cover:
A large oak log (*Quercus macrocarpa*) collected in the Assiniboine River for dendrochronological analysis, radiocarbon dated at 1120 ± 60 years (GSC-5212).

Georeference:
Manitoba

Suggested reference:
Morlan, R.E., McNeely, R., and Nielsen, E. 2000: Manitoba radiocarbon dates; Manitoba Industry, Trade and Mines, Geological Survey, Open File Report OF2000-1, 198 p.

Publication:
Produced by Ohana Productions and PALEOTEC Services. To view a slightly modified pdf version of this publication, see <<http://sts.gsc.nrcan.gc.ca/radiocarbon/pdf_e.shtml>>.

102-00188/

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Open File Report OF2000-1

Manitoba Radiocarbon Dates:
Geological Radiocarbon Dates (Section I), Archaeological Radiocarbon Dates (Section II).

Section I collated by R. McNeely and E. Nielsen
Section II collated by R.E. Morlan
Winnipeg, 2000

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MANITOBA RADIOCARBON DATES

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MANITOBA RADIOCARBON DATES

Abstract

This open file report is a Date List that presents more than 1000 radiocarbon age determinations made by various radiocarbon dating laboratories since 1960 on samples collected in Manitoba. The dates are presented in two sections: i) geological samples (~650) and ii) archaeological samples (~350). The geological dates have been organized thematically on the following topics: Climate change; Fluvial activity; Peat development; Modern lakes; Sea level change; Glacial lakes; Pre-Holocene dates; as well as Paleontology and geoarchaeology. The archaeological dates include cultural affiliations and associated vertebrate faunas, where identified, and have been presented based on their Borden designation. Thirteen laboratories have been involved in dating geological samples (GSC, BGS, Beta, CAMS, I, GX, S, WIS, TO, Y, QU, W, and RIDDL), whereas seventeen laboratories have dated archaeological materials (S, GX, BGS, GaK, Beta, AECV, I, A, CAMS, SFU, TO, GSC, DIC, NSRL, OxA, RIDDL, and Y).

These data are also available on the Web at the Geological Survey of Canada Radiocarbon Dating Laboratory's WebPage at <<http://sts.gsc.nrcan.gc.ca/radiocarbon>> in the 'Database/Open File' module, and the archaeological data are available interactively in 'Mapping Ancient History' at <<http://www.geoserv.org>> and on the 'Canadian Archaeological Radiocarbon Database' at <<http://www.canadianarchaeology.com/radiocarbon/card/card.htm>>.

Résumé

Ce dossier public contient plus de 1000 datations au carbone radioactif déterminées par différents laboratoires sur des échantillons provenant du Manitoba depuis 1960. Les dates sont reparties en deux sections: i) échantillons géologiques (~650) et ii) échantillons archéologiques (~350). Les datations géologiques ont été organisées sur une base thématique selon les sujets suivant: Changement climatique; Activité fluviale; Croissance de tourbe; Lacs modernes; Variation du niveau marin; Lacs glaciaires; Dates pré-Holocène; et, Paléontologie et géoarchéologie. Les datations archéologiques incluent les affiliations culturelles et la faune de vertébrés associée, elles sont présentées sur la base de la désignation Borden. Treize laboratoires sont impliqués dans la datation des échantillons géologiques (CGC, BGS, Beta, CAMS, I, GX, S, WIS, TO, Y, QU, W, et RIDDL), alors que dix-sept ont déterminé des dates de matériel archéologique (S, GX, BGS, GaK, Beta, AECV, I, A, CAMS, SFU, TO, CGC, DIC, NSRL, OxA, RIDDL, et Y).

Ces dates sont également disponibles sur internet sur le site du laboratoire de la Commission géologique du Canada: <<http://sts.gsc.nrcan.gc.ca/radiocarbon>> dans le module 'Base de données/Dossiers publics', et les données archéologiques sont disponibles sur le site interactif 'L'Histoire ancienne – La Carte' <<http://www.geoserv.org>> et sur le site 'Datations par Radiocarbone en Archéologie Canadienne' <<http://www.canadianarcheology.com/radiocarbon/fcard/fcard.htm>>.

SECTION I

GEOLOGICAL RADIOCARBON DATES IN MANITOBA

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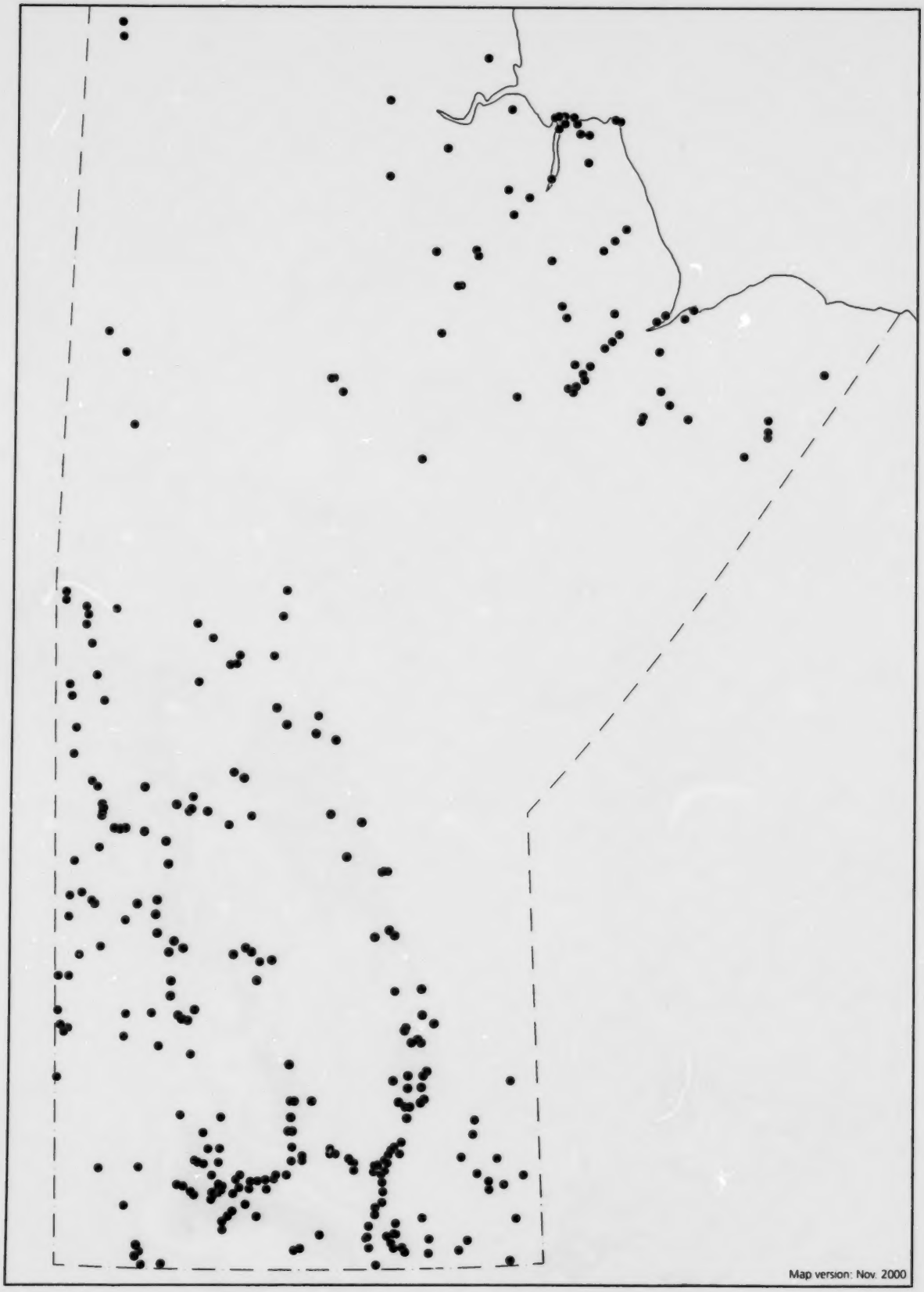

Figure 1. Distribution of geological dates in Manitoba. See individual maps (Figs. 2-12) for details.

INTRODUCTION

All dates published (cf. Teller, 1980) or provided to the authors prior to January 2000 are now available in this Date List. For ease of association the presentation of the geological dates has been organized thematically and presented from the east to the west within each theme. The 655 geological dates (Fig. 1) relate to the following themes: climate change (122), fluvial activity (117), peat deposits (85), modern lakes (177), glacial lakes (52), sea level change (61), pre-Holocene samples (33), and dates related to paleontology and geoarchaeology (9). All dates (352) related to archaeological sites are presented in Section II of this Open File.

All age calculations are based on the 'Libby' ^{14}C half-life of 5568 ± 30 years and 0.95 of the activity of the NBS oxalic acid standard. Ages are quoted in radiocarbon years before present (RP), where 'present' is taken to be AD 1950 (Stuiver and Polach, 1977). The error assigned to each age is conventionally reported as ± 1 sigma, except for the GSC Laboratory which unconventionally reports its error term as ± 2 sigma. This deviation from convention must be taken into account when calibrating the GSC dates. The GSC error must be divided by 2 prior to using the calibration program (Note: the external error multiplier (EEM) for the GSC Laboratory is 1.6). Please refer to WebPage <<http://sts.gsc.nrcan.gc.ca/radiocarbon/agecal_e.shtml>> for additional details.

If $^{13}C/^{12}C$ ratio ($\delta^{13}C$) was available, a 'normalization' for isotopic fractionation was applied to the sample age, and the $\delta^{13}C$ value reported. Therefore, by convention the dates are normalized to a $\delta^{13}C$ = -25.0‰ PDB unless otherwise indicated. Some laboratories, including many of the AMS laboratories, assume a $\delta^{13}C$ for the material dated and provide a normalized age only. Whenever possible, these assumptions are noted in the presentation of the data. Only about a third (214) of the dates have measured $\delta^{13}C$, and 100 dates have assumed $\delta^{13}C$, thus half of the dates are reported without 'normalization' (uncorrected).

Special notes:

i) the GSC Laboratory unconventionally 'corrects' marine shell ages to a $\delta^{13}C$ = 0.0‰ PDB ('corrected' age) in an attempt to account for the marine reservoir age of the sample;
ii) the 'hardwater' error for freshwater shells is not well documented, therefore, the GSC Laboratory does not 'correct' freshwater shell ages. The user of these dates should be aware of this complication whenever comparisons between terrestrial and freshwater dates are attempted. A correction for the 'hardwater' error must be applied to these data in order to make the comparisons valid (cf. GSC-6266 versus -6253; GSC-6087 versus TO-5699; CAMS-35495 versus -32193; CAMS-35496, -35501 versus -35615; CAMS-38680 versus -35616; GSC-797, -870, -902 versus GSC-689; and modern collections, GSC-3281 and BGS-1099).

The 655 geological dates have been produced by 13 laboratories for 51 different submitters. Ten submitters have dated 20 samples or more, and 13 submitters have dated between 5 and 20 samples, whereas 28 submitters have dated less than 5 samples.

The age distribution of the geological samples, except for first millennium BP, is reasonably uniform back to 11 ka, i.e. immediately after deglaciation in the south of the province. A number of late glacial and older samples (pre-Holocene) have also been found in Manitoba.

millennium	no.	millennium	no.
modern	29	7 to 8 ka	33
0 to 1 ka	115	8 to 9 ka	11
1 to 2 ka	65	9 to 10 ka	24
2 to 3 ka	74	10 to 11 ka	19
3 to 4 ka	63	11 to 12 ka	6
4 to 5 ka	74	12 to 20 ka	6
5 to 6 ka	46	>20 ka	12
6 to 7 ka	50	nonfinite	24

The type of materials dated is varied but certain materials (e.g. wood) are more prevalent than others and in most cases is dependent on availability rather than submitter preference.

bone	32	shells, marine	52
charcoal	44	shells, freshwater	115
lake sediment	52	ostracodes	5
organic material	86	soil/paleosol	26
peat	95	wood	144

The taxa dated are quite varied within the foregoing categories and are noted in Table 1 with their frequency of occurrence.

Table 1. Taxa of geological material dated

Taxon	no.	Taxon	no.	Taxon	no.	Taxon	no.
Macrofossils		*Polygonum*	1	**Marine bivalve shells**		*Lymnaea*	2
plants		*Ranunculus*	1	**pelecypods (clams)**		*Probythinella*	1
Scirpus	28	*Scorpidium*	1	*Hiatella*	23	**pelecypods (clams)**	
Sphagnum	15	**insects**		*Mytilus*	10	*Sphaerium*	30
Carex	7	*Agonum*	1	*Macoma*	5	*Lampsilis*	19
Chenopodium	3	*Amara*	1	*Chlamys*	4	Unionidae	4
Rumex	3	*Hypera*	1	*Mya*	3	*Amblema*	2
Cyperaceae	2	**Arboreal plants (trees)**		*Clinocardium*	1	*Lasmigona*	1
Potentilla	2	*Picea* (spruce)	34	*Astarte*	1	*Pisidium*	1
Rubus	2	*Quercus* (oak)	18	**Freshwater shells**		*Strophitus*	1
Bidens	1	*Salix* (willow)	13	**gastropods (snails)**		**ostracodes**	
Drepanocladus	1	*Larix* (tamarack)	11	*Marstonia*	18	*Candona*	5
Helianthus	1	*Fraxinus* (ash)	6	*Stagnicola*	11	**Vertebrates (mammals)**	
Juniperus	1	*Populus* (poplar)	5	gastropod	5	*Bison*	19
Lycopus	1	*Ulmus* (elm)	2	*Amnicola*	2	*Mammuthus* (mammoth)	2
Mentha	1	*Alnus* (alder)	2	*Gyraulus*	2	*Ovibos* (muskox)	1

Acknowledgements

Our sincere appreciation is expressed to G.E. Tackman for making available his extensive database related to glacial rebound in Manitoba. For more extensive comments and interpretation of the dates submitted by G.E. Tackman please refer to Tackman (1997), and Tackman, et al. (1998). Additional field assistance to G.E. Tackman and D. Currey was provided by D. Roberts, T. Wambeam, M. Finco and G. Atwood during the project. Financial support for Tackman's Ph.D. research was provided by NASA (Grant Number NAG 5-2055) with additional support from GSA (5718-95) and both are gratefully acknowledged.

A special thanks is due to H. Melville of the Brock Geological Sciences (BGS) Laboratory who provided considerable clarification on numerous heretofore unpublished dates, that were provided by E. Nielsen, which have now been made public in this Date List. The additional data he provided has made many of the dates useful rather than just present. G. Matile untiringly provided useful insights on many of the older samples dated, especially those related to Lake Agassiz chronology.

L.H. Thorleifson, because of his personal interest in this region, was a continuing source of support and encouragement for this endeavour, which at times seemed never-ending to him. Our thanks to him for his commitment in making this Date List as complete as possible.

Identification of materials used for dating or associated with the dated material has been noted where available. Detailed macrofossil reports, provided by A. Telka, have been incorporated into the text for reference and completeness of the analyses, especially for those dates related to the Lake Winnipeg Project (Todd, et al., 2000).

Financial support for the publication of this Date List has generously been provided by L.H. Thorleifson, S.A. Wolfe, E. Nielsen, and R. McNeely. The development of the PDF document was undertaken and skilfully executed, under contract, by Ohana Productions (J.V. Matthews, Jr.).

RADIOCARBON DATES RELATED TO CLIMATE CHANGE

Dendrochronological samples in south-central Manitoba (Fig. 2)

Wood samples were collected from the south shore of Lake Winnipeg and along the Assiniboine River west of Winnipeg to construct a dendrochronology for south central Manitoba. The logs were lying in the water or on the shore having been eroded out of the previously deposited point bars or pushed up by winter shore ice in the case of the Lake Winnipeg samples. None of the samples were found in any significant stratigraphic context. The logs were selected from hundreds of driftwood samples solely on the basis that they 'looked old'.

GSC-5264 Beaconia Beach

normalized age: 590 ± 50
$\delta^{13}C$= -26.2‰
uncorrected age: 610 ± 50

The wood (*Larix*; identified by H. Jetté (unpublished GSC Wood Report No. 91-45)) was enclosed in sand and clay. Sample NB-90-8 was collected by E. Nielsen on October 25, 1990, from Beaconia Beach on the southeastern shore of the south basin of Lake Winnipeg, Manitoba (50°26'50"N, 96°34'35"W), at an elevation of 217 m; submitted by E. Nielsen.

GSC-5269 Patricia Beach

normalized age: modern
$\delta^{13}C$= -27.6‰
uncorrected age: 90 ± 50

The wood (*Salix*; identified by H. Jetté (unpublished GSC Wood Report No. 91-48)) was enclosed in sand. Sample NB-90-5 was collected by E. Nielsen on October 25, 1990, from Patricia Beach on the southeastern shore of the south basin of Lake Winnipeg, Manitoba (50°26'10"N, 96°35'20"W), at an elevation of 217.4 m; submitted by E. Nielsen.

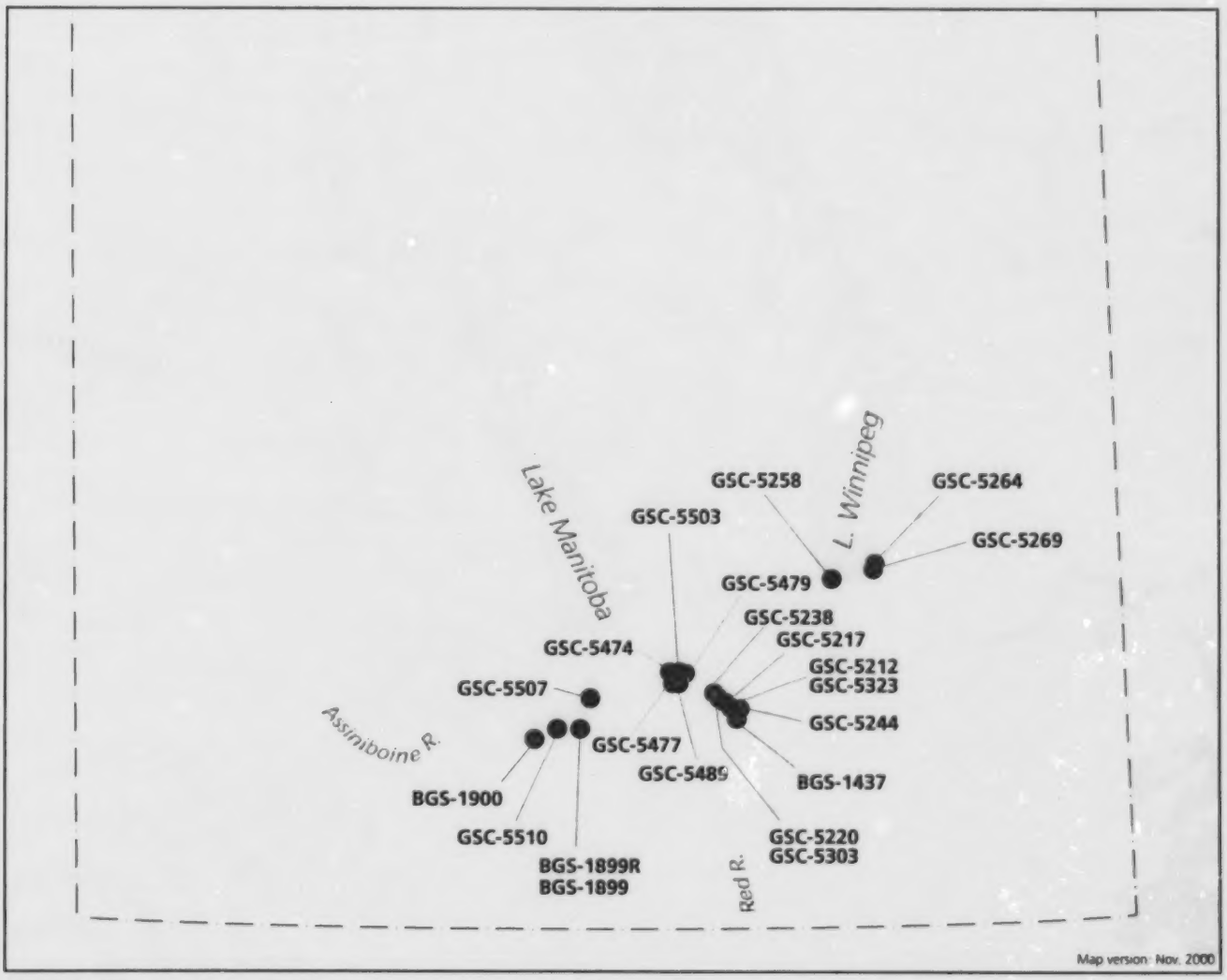

Figure 2. Radiocarbon dates providing calibration for dendrochronologic studies.

GSC-5258 Red River mouth

normalized age: modern
$\delta^{13}C$= -25.9‰
uncorrected age: 20 ± 60

The wood (*Ulmus americana*; identified by H. Jetté (unpublished GSC Wood Report No. 91-41)) was enclosed in silty clay. Sample NB-90-2(c) was collected by E. Nielsen on June 25, 1990, from 4 km west of the main channel of the Red River on the southern shore of the south basin of Lake Winnipeg, Manitoba (50°24'10"N, 96°51'55"W), at an elevation of 217 m; submitted by E. Nielsen.

BGS-1437 Assiniboine River I (26 km)

uncorrected age: 920 ± 70

The basal wood (*Quercus macrocarpa* log; cf. GSC-5244 (unpublished GSC Wood Report No. 91-38)) was enclosed in alluvial silt. Sample BP 5(b) was collected by E. Nielsen on May 31, 1990, from 1 km south of the Trans-Canada Highway in Beaudry Park on the Assiniboine River, 26 km west of junction with Red River, Manitoba (49°50'30"N, 97°30'00"W), at an elevation of 238 m; submitted by E. Nielsen.

Comment (E. Nielsen): Large log at the base of the section. Log probably protruding from river bank but contact obscured by slumped sediment. Sample was wet. Log may be modern, i.e. jammed into the section by river ice or may date first occupation of valley by modern Assiniboine River.

GSC-5244 Assiniboine River I (26 km)

normalized age: 870 ± 60
$\delta^{13}C$= -26.4‰
uncorrected age: 900 ± 60

The wood (*Quercus macrocarpa*; identified by R.J. Mott (unpublished GSC Wood Report No. 91-38)) was enclosed in alluvial silt. Sample B.P.-90-5(b) was collected by E. Nielsen on May 31, 1990, from 1 km south of the Trans-Canada Highway in Beaudry Park on the Assiniboine River, 26 km west of junction with Red River, Manitoba (49°52'30"N, 97°29'30"W), at an elevation of 238 m; submitted by E. Nielsen.

GSC-5212 Assiniboine River II (29 km)

normalized age: 1120 ± 60
$\delta^{13}C$= -27.1‰
uncorrected age: 1150 ± 60

The wood (*Quercus macrocarpa*; identified by E. Nielsen) was enclosed in water. Sample Assin-91-1 was collected by E. Nielsen on May 23, 1991, from 0.5 km north of the Trans-Canada Highway in the Assiniboine River, 29 km west of junction with Red River, Manitoba (49°53'30"N, 97°32'00"W), at an elevation of 239 m; submitted by E. Nielsen.

GSC-5323 Assiniboine River III (29.5 km)

normalized age: 200 ± 60
$\delta^{13}C$= -25.2‰
uncorrected age: 200 ± 60

The wood (*Quercus macrocarpa*; identified by H. Jetté (unpublished GSC Wood Report No. 91-86)) was on the river bottom. Sample Assin-91-6 was collected by E. Nielsen on September 24, 1991, from the Assiniboine River, 1.25 km north of the Trans-Canada Highway and 29.5 km west of junction with Red River, Manitoba (49°53'35"N, 97°32'10"W), at an elevation of 239 m; submitted by E. Nielsen.

GSC-5217 Assiniboine River IV (30.5 km)

normalized age: 1570 ± 60
$\delta^{13}C$= -25.7‰
uncorrected age: 1580 ± 60

The wood (*Quercus macrocarpa*; identified by H. Jetté (unpublished GSC Wood Report No. 91-30)) was a surface collection on the river bed. Sample Assin-91-2 was collected by E. Nielsen on May 23, 1991, from 2 km north of the Trans-Canada Highway in the Assiniboine River, 30.5 km west of junction with Red River, Manitoba (49°54'30"N, 97°33'20"W), at an elevation of 239 m; submitted by E. Nielsen.

GSC-5503 Marquette II

normalized age: 70 ± 60
$\delta^{13}C$= -26.7
uncorrected age: 100 ± 60

The wood (*Quercus* probably *macrocarpa*; identified by H. Jetté (unpublished GSC Wood Report No. 92-87)) was a surface collection on fluvial silt. Sample Assin-92-6 was collected by E. Nielsen on May 13, 1992, from 6 km south-southwest of Marquette along the south shore of the Assinboine River in south central Manitoba (50°00'59"N, 97°45'25"W), at an elevation of 241 m; submitted by E. Nielsen.

GSC-5489 Marquette III

normalized age: 260 ± 50
$\delta^{13}C$= -24.4‰
uncorrected age: 250 ± 50

The wood (*Quercus* probably *macrocarpa*; identified by H. Jetté (unpublished GSC Wood Report No. 92-86)) was a large log sticking out of the water. Sample Assin-92-5 was collected by E. Nielsen on May 13, 1992, from 7.5 km southeast of Marquette along the north shore of the Assiniboine River in south-central Manitoba (50°00'20"N, 97°46'50"W), at an elevation of 242 m; submitted by E. Nielsen.

GSC-5477 Poplar Point I

normalized age: 90 ± 60
$\delta^{13}C$= -23.5‰
uncorrected age: 60 ± 60

The wood (*Quercus* probably *macrocarpa*; identified by H. Jetté (unpublished GSC Wood Report No. 92-83)) was a surface collection on shore. Sample Assin-92-3 was collected by E. Nielsen on May 12, 1992, from 13.5 km southeast of Poplar Point along the Assiniboine River, about halfway between Winnipeg and Portage la Prairie, in south-central Manitoba (50°00'30"N, 97°48'15"W), at an elevation of 242 m; submitted by E. Nielsen.

GSC-5474 Poplar Point II

normalized age: modern
$\delta^{13}C$= -26.5‰
uncorrected age: 20 ± 60

The wood (*Populus*; identified by H. Jetté (unpublished GSC Wood Report No. 92-82)) was enclosed in water. Sample Assin-92-2 was collected by E. Nielsen on May 12, 1992, from 12 km southeast of Poplar Point, along Assiniboine River, south-central Manitoba (50°00'59"N, 97°49'10"W), at an elevation of 242 m; submitted by E. Nielsen.

BGS-1899 Portage la Prairie I

uncorrected age: 3228 ± 85

The wood (oak log; identified by E. Nielsen) was a surface collection at the edge of the river. Sample Assin 95-1 was collected by E. Nielsen in August 1995, from Assiniboine River, about 26 km southwest of Portage la Prairie City Hall, Manitoba (49°46'20"N, 98°23'20"W), at an elevation of about 272 m; submitted by E. Nielsen.

BGS-1899 R Portage la Prairie I

uncorrected age: 3246 ± 95

The wood (oak log; identified by E. Nielsen) was a surface collection at the edge of the river. Sample Assin 95-1 was collected by E. Nielsen in August 1995, from Assiniboine River, about 26 km southwest of Portage la Prairie City Hall, Manitoba (49°46'20"N, 98°23'20"W), at an elevation of about 272 m; submitted by E. Nielsen.

Comment (E. Nielsen): This is a repeat crosscheck on the original date BGS-1899.

GSC-5507 Portage la Prairie II

normalized age: 90 ± 60
$\delta^{13}C$= -27.3‰
uncorrected age: 130 ± 60

The wood (*Quercus* probably *macrocarpa*; identified by H. Jetté (unpublished GSC Wood Report No. 92-88)) was enclosed in silty clay under 1 m of silty clay. Sample Assin-92-9 was collected by E. Nielsen on May 14, 1992, from the bank of the Assiniboine River, 13 km southwest of Portage la Prairie City Hall, Manitoba (49°53'00"N, 98°24'50"W), at an elevation of about 265 m; submitted by E. Nielsen.

GSC-5510 Portage la Prairie III

normalized age: 190 ± 60
$\delta^{13}C$= -25.0‰
uncorrected age: 190 ± 60

The wood (*Quercus* probably *macrocarpa*; identified by H. Jetté (unpublished GSC Wood Report No. 93-01)) was enclosed in silty clay at the base of homogeneous alluvial silt and clay about 2 m-thick. Sample Assin-92-10 was collected by E. Nielsen on May 14, 1992, from the north bank of the Assinboine River, 28 km southwest of Portage la Prairie City Hall, Manitoba (49°45'20"N, 98°29'30"W), at an elevation of about 270 m; submitted by E. Nielsen.

BGS-1900 Treherne

uncorrected age: 1275 ± 75

The wood (oak log; identified by E. Nielsen) was a surface collection at the edge of the river. Sample 'Assin 95-2' was collected by E. Nielsen in August 1995, from Assiniboine River, 15 km northeast of Treherne, Manitoba (49°44'40"N, 98°35'30"W), at an elevation of about 274 m; submitted by E. Nielsen.

General comment (E. Nielsen): The subfossil oak samples (*Quercus macrocarpa*) will be crossdated with modern oak trees and logs from historic buildings in Winnipeg to anchor the chronology in A.D. 1990. As the subfossil logs range in age from 1580 ± 60 years BP (GSC-5217) to 20 ± 60 years BP, i.e. modern (GSC-5258), it should be possible as more material becomes available to construct a dendrochronology spanning the last 2000 years using oak for south-central Manitoba.

GSC-5303 Assiniboine River V (31.2 km)

normalized age: 180 ± 50
$\delta^{13}C$= -25.1‰
uncorrected age: 180 ± 50

The wood (*Quercus macrocarpa*; identified by H. Jetté (unpublished GSC Wood Report No. 91-60)) was in the water. Sample Assin-91-5 was collected by E. Nielsen on September 24, 1991, from the Assiniboine River, 3.5 km north of the Trans-Canada Highway and 31.2 km west of junction with Red River, Manitoba (49°55'15"N, 97°33'45"W), at an elevation of 239 m; submitted by E. Nielsen.

GSC-5220 Assiniboine River VI (30.5 km)

normalized age: 90 ± 80
$\delta^{13}C$= -27.4‰
uncorrected age: 130 ± 80

The wood (*Quercus macrocarpa*; identified by H. Jetté (unpublished GSC Wood Report No. 91-32)) was enclosed in water. Sample Assin-91-3 was collected by E. Nielsen on May 23, 1991, from 3.50 km north of the Trans-Canada Highway in the Assiniboine River, 30.5 km west of junction with Red River, Manitoba (49°55'10"N, 97°34'25"W), at an elevation of 239 m; submitted by E. Nielsen.

GSC-5238 Assiniboine River VII (32.7 km)

normalized age: 430 ± 60
$\delta^{13}C$= -26.2‰
uncorrected age: 450 ± 60

The wood (*Quercus macrocarpa*; identified by H. Jetté (unpublished GSC Wood Report No. 91-36)) was enclosed in water. Sample Assin-91-4 was collected by E. Nielsen on May 23, 1991, from 4.75 km north of the Trans-Canada Highway in the Assiniboine River, 32.7 km west of junction with Red River, Manitoba (49°55'40"N, 97°35'00"W), at an elevation of 239 m; submitted by E. Nielsen.

GSC-5479 Marquette I

normalized age: 520 ± 60
$\delta^{13}C$= -24.8‰
uncorrected age: 520 ± 60

The wood (*Quercus* probably *macrocarpa*; identified by H. Jetté (unpublished GSC Wood Report No. 92-85)) was enclosed in silty clay. Sample Assin-92-4 was collected by E. Nielsen on May 12, 1992, from 6 km south of Marquette along the north shore of Assiniboine River, Manitoba (50°00'40"N, 97°44'40"W), at an elevation of 241 m; submitted by E. Nielsen.

Radiocarbon Dates related to Eolian Activity (Fig. 3)

BGS-1752 Winnipeg

uncorrected age: 2925 ± 90

The paleosol (organic silt) was enclosed in calcareous silt and clay in Lake Agassiz clay. Sample Ken 94-1 from 0.5 m depth was collected by E. Nielsen on November 16, 1994, in a drainage ditch along Route 90 at the south end of Winnipeg, Manitoba (49°49'30"N, 97°12'15"W), at an elevation of 234 m. This sample was submitted by E. Nielsen to gain information on climate change, specifically a dry interval (drought).

Comment (E. Nielsen): The date indicates a time of arid climate.

CAMS-30745 Spruce Woods

normalized age: 1430 ± 60

The humic extract of a 2Ab paleosol in dune sand; sample 'MB-48-2Ab' from 22-40 cm depth was collected by S.A. Wolfe and D.R. Muhs in a borrow pit exposure south of Spruce Woods Provincial Park boundary, Brandon Sand Hills, southwestern Manitoba (49°36'29"N, 99°04'10"W), at an elevation of 366 m. This sample was submitted by D.R. Muhs to gain information on eolian (dune) stability.

The age was normalized assuming a $\delta^{13}C$ of -25‰. The 2 sigma calibrated age is 1262 (1310) 1415.

Consult CAMS-30733 (below, p. 11) for comments.

CAMS-30746 Brandon Sand Hills

normalized age: 2150 ± 60

The humic extract of a 3Ab paleosol in dune sand; sample 'MB-48-3Ab' from 55 cm depth was collected by S.A. Wolfe and D.R. Muhs from the Brandon Sand Hills, southwestern Manitoba (49°36'29"N, 99°04'22"W), at an elevation of 366 m. This sample was submitted by D.R. Muhs to gain information on eolian (dune) stability.

The age was normalized assuming a $\delta^{13}C$ of -25‰. The 2 sigma calibrated age is 1952 (2125 2139 2146) 2332.

CAMS-30734 Spruce Woods

normalized age: 2180 ± 55

The humic extract of a 2Ab paleosol in dune sand; sample 'MB-22-2Ab' from 100-110 cm depth was collected by S.A. Wolfe and D.R. Muhs from a north-facing roadcut south of Spruce Woods Provincial Park, Brandon Sand Hills, southwestern Manitoba (49°38'48"N, 99°15'00"W), at an elevation of 366 m. This sample was submitted by D.R. Muhs to gain information on eolian (dune) stability.

The age was normalized assuming a $\delta^{13}C$ of -25‰. The 2 sigma calibrated age is 2003 (2151 2273 2291) 2338.

CAMS-35808 Spirit Sands

normalized age: 490 ± 40

The humic extract of a 2Ab paleosol in dune sand; sample 'MB-2-2Ab' from 60 cm depth was collected by D.R. Muhs on June 13, 1996, from an exposure in the parking lot of Spirit Sands trail head, Brandon Sand Hills, southwestern Manitoba (49°39'44"N, 99°16'15"W), at an elevation of 335 m. This sample was submitted by D.R. Muhs to gain information on eolian (dune) stability.

The age was normalized assuming a $\delta^{13}C$ of -25‰. The 2 sigma calibrated age is 496 (520) 617.

CAMS-30706 Brandon Sand Hills

normalized age: 2205 ± 55

The humic extract of a 2Ab paleosol in dune sand; sample 'MB-14-2Ab' from 75 cm depth was collected by S.A. Wolfe and D.R. Muhs on June 11, 1997, from a roadcut exposure of a low (about 3 m high) dune, Brandon Sand Hills, southwestern Manitoba (49°40'00"N, 99°12'30"W), at an elevation of 335 m. The dune was mainly under grass, chokecherry, occasional spruce, *Juniper horizontalis*, and aspen. This sample was submitted by D.R. Muhs to gain information on eolian (dune) stability.

The age was normalized assuming a $\delta^{13}C$ of -25‰. The 2 sigma calibrated age is 2045 (2157 2169 2178 2265 2300) 2345.

Y-410 Bald Head Hills

normalized age: modern

The wood was enclosed in a 30 cm-thick humified zone (paleosol) within an active sand dune. Sample C-55-3 was collected by R.D. Bird in 1955, from Bald Head Hills, 45 km east and 19 km south of Brandon, on the Assiniboine River delta, Manitoba (49°40'52"N, 99°18'18"W). This sample was submitted by J.A. Elson to gain information on climate change, specifically a humid interval.

Comment (J.A. Elson): The dunes have been active since 1740 AD at least, and the fossil soil is believed to represent an earlier period of humid climate. There are at least two buried soils in the district, and the date suggests that this sample was from a horizon younger than was originally supposed.

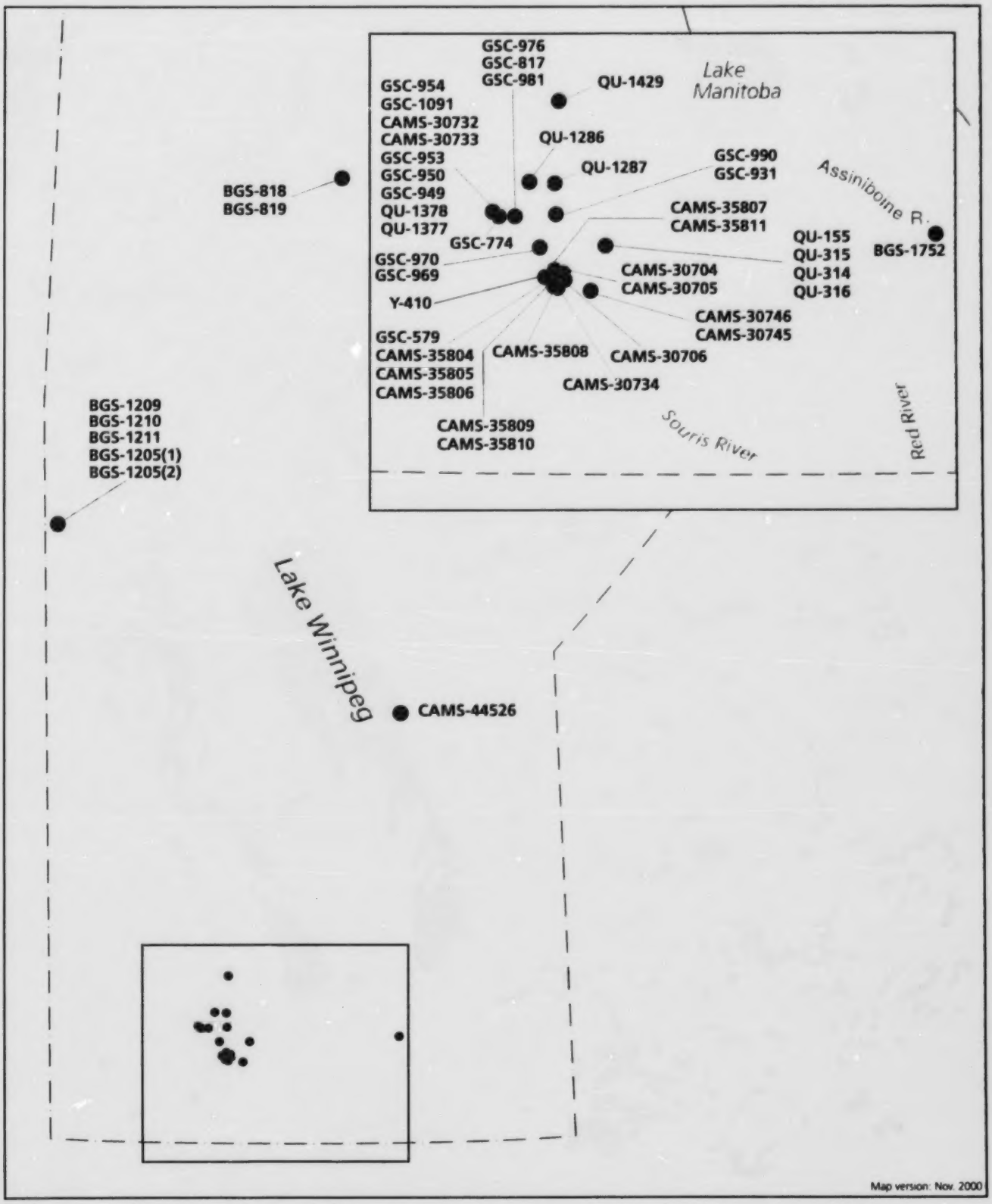

Figure 3. Radiocarbon dates related to eolian activity. Inset shows dates in area marked by rectangle in southwestern Manitoba.

Spirit Sands A Series

A series of samples from an exposure on east side of highway 5, 1.2 miles north of Spirit Sands turnoff, Brandon Sand Hills, southwestern Manitoba (49°40'57"N, 99°15'56"W), at an elevation of 335 m, was collected by D.R. Muhs on June 13, 1996. These samples were submitted by D.R. Muhs to gain information on eolian (dune) stability.

CAMS-35804 Spirit Sands I

normalized age: modern

The wood sample 'MB-3-3Ab wood #1' from 285 cm depth was enclosed in dune sand.

The age was normalized assuming a $\delta^{13}C$ of -25‰. The calibrated age is pre-AD 1950.

CAMS-35805 Spirit Sands II

normalized age: >modern

The wood sample 'MB-3-3Ab wood #2' from 285 cm depth was enclosed in dune sand.

The age was normalized assuming a $\delta^{13}C$ of -25‰. The calibrated age is post AD 1950.

CAMS-35809 Spirit Sands III

normalized age: modern

The humic extract of sample 'MB-3-2Ab' from 110 cm depth was enclosed in a 2Ab paleosol in dune sand.

The age was normalized assuming a $\delta^{13}C$ of -25‰. The calibrated age is pre-AD 1950.

CAMS-35810 Spirit Sands IV

normalized age: >modern

The humic extract of sample 'MB-3-3Ab' from 285 cm depth was enclosed in a 3Ab paleosol in dune sand.

The age was normalized assuming a $\delta^{13}C$ of -25‰. The calibrated age is post AD 1950.

CAMS-35806 Spirit Sands V

normalized age: 140 ± 40

The wood sample 'MB-3-3Ab wood #3' from 285 cm depth was enclosed in dune sand.

The age was normalized assuming a $\delta^{13}C$ of -25‰. The 2 sigma calibrated age is 0 (2 24 142 218 265) 288.

Consult CAMS-30733(below, p. 11) for comments.

GSC-579 Glenboro

uncorrected age: 2330 ± 130

The wood was enclosed in buried soil formed on 1 m of highly organic, sandy alluvium over varved clay. Sample KJ-16-65 was collected by R.W. Klassen on September 14, 1965, from the north wall of Assiniboine River valley about 2.4 km north of Glenboro, Manitoba (49°41'N, 99°16'W). This sample was submitted by R.W. Klassen to gain information on eolian activity.

Comment (R.W. Klassen): The sample was taken from beneath 14 m of eolian sand forming the valley wall. The eolian sand was deposited on the dated soil during a major episode of dune formation on the surface of the Lake Agassiz delta of the Assiniboine River.

Spruce Woods Series

A series of samples from a blowout exposure on the road leading down to Assiniboine River floodplain, east of Spruce Woods Provincial Park campground, Brandon Sand Hills, southwestern Manitoba (49°41'29"N, 99°12'30"W), at an elevation of 335 m, was collected by S.A. Wolfe and D.R. Muhs on June 11, 1997. These samples were submitted by D.R. Muhs to gain information on eolian (dune) stability.

CAMS-30704 Spruce Woods I

normalized age: 670 ± 45

The humic extract of sample 'MB-12-2Ab' from 115 cm depth was enclosed in a 2Ab paleosol in dune sand.

The age was normalized assuming a $\delta^{13}C$ of -25‰. The 2 sigma calibrated age is 551 (653) 676.

CAMS-30705 Spruce Woods II

normalized age: 1600 ± 45

The humic extract of sample 'MB-12-3Ab' from 390 cm depth was enclosed in a 3Ab paleosol in dune sand.

The age was normalized assuming a $\delta^{13}C$ of -25‰. The 2 sigma calibrated age is 1355 (1520) 1595.

Consult CAMS-30733 (below, p. 11) for comments.

Spirit Sands B Series

A series of samples from an exposure on east side of highway 5, 2.35 miles north of Spirit Sands turnoff, Brandon Sand Hills, southwestern Manitoba (49°42'46"N, 99°15'56"W), at an elevation of 335 m, was collected by D.R. Muhs on June 13, 1996. This sample was submitted by D.R. Muhs to gain information on eolian (dune) stability.

CAMS-35807 Spirit Sands I

normalized age: >modern

The charcoal sample 'MB-4-2Ab' from 70 cm depth was enclosed in dune sand.

The age was normalized assuming a $\delta^{13}C$ of -25‰. The calibrated age is post AD 1950.

CAMS-35811 Spirit Sands II

normalized age: modern

The humic extract of sample MB-4-2Ab (70 cm depth), was from the 2Ab paleosol in the sand dune.

The age was normalized assuming a $\delta^{13}C$ of -25‰. The calibrated age is pre-AD 1950.

Consult CAMS-30733 (below, p. 11) for comments.

Pratt Series

A series of paleosol samples from a roadcut on the south side of the road about 2.5 km south of Pratt and 4.5 km west of highway 34, about 18 km south of Austin, southwestern Manitoba (49°47'02"N, 98°59'23"W), at an elevation of 366 m, was collected by P.P. David in 1970. These samples were submitted by P.P. David to gain information on eolian activity, and climate change.

QU-155 Pratt I

normalized age: 1510 ± 100

The soil, humus-rich sand of 2Ab horizon (M-14-70), from 95 cm depth was enclosed in a Chernozem soil in dune sand.

The age was normalized assuming a $\delta^{13}C$ of -25‰. The 2 sigma calibrated age is 1263 (1392 1401 1406) 1686.

QU-315 Pratt II

normalized age: 4540 ± 250

The soil, humus-rich sand of 4Ab horizon (M-14-70) from 235 cm depth was enclosed in a Chernozem soil in dune sand.

The age was normalized assuming a $\delta^{13}C$ of -25‰. The 2 sigma calibrated age is 4451 (5294) 5843.

QU-314 Pratt III

normalized age: 4560 ± 370

The soil, humus-rich sand of 5Ab horizon (M-14-70) from 290 cm depth was enclosed in a Chernozem soil in dune sand.

The age was normalized assuming a $\delta^{13}C$ of -25‰. The 2 sigma calibrated age is 4161 (5301) 6168.

Comment (P.P. David): The area around the Pratt site is characterized by high groundwater levels, ephemeral lakes and swampy terrain. Almost every roadcut has more than one buried Ah horizon. This site appears to be important in that it has ten paleosol horizons. All paleosols show strong bioturbation (burrow-filling gopher holes and smaller animals). The top is vegetated and the upper horizons dip east, as does the dune surface (at 17°), and are truncated at their western limit by a 15° surface (all inclinations are apparent).

Stratigraphy:

000-010 cm	surface Ah horizon, darker in upper few centimetres;
010-090 cm	dune sand, light greyish at top oxidized yellow below; sharp basal contact inclined at 11°;
090-120 cm	contains first buried soil from the surface; the upper 5 cm is transitional with lighter coloured Ahb horizon; the rest is very dark; sampled very dark zone at 95 cm (QU-155); the soil becomes darker towards the center of dune but is strongly mottled light grey and yellow from burrow fillings;
120-143 cm	lighter coloured (from humus) grey sand; elsewhere the colour is much lighter; base inclined at 8°

QU-316 Pratt IV

normalized age: 2780 ± 170

The soil, humus-rich sand (3Ab horizon), was enclosed in a Chernozem soil in dune sand. Sample M-14-70 from 150 cm depth was collected by P.P. David in 1970, from a roadcut on south side of the road about 2.5 km south of Pratt and 4.5 km west of highway 34, about 18 km south of Austin, southwestern Manitoba (49°47'02"N, 98°59'26"W), at an elevation of 366 m. This sample was submitted by P.P. David to gain information on eolian activity and climate change, specifically periods of drought.

The age was normalized assuming a $\delta^{13}C$ of -25‰. The 2 sigma calibrated age is 2364 (2866) 3357.

Carberry Series

A series of soil samples, humus-rich sandy matter from Ah horizon of 2 buried Chernozem soils exposed in a roadcut through a stabilized dune on east side of highway 258 in the Brandon Sand Hills, 7.36 km south of Carberry, southwestern Manitoba (49°47'25"N, 99°21'00"W), at an elevation of about 385 m, was collected by P.P. David on August 17, 1967. These samples were submitted by P.P. David to gain information on eolian processes, and climate change.

GSC-970 Carberry I

normalized age: 1910 ± 130
$\delta^{13}C$= -21.5‰
uncorrected age: 1860 ± 130

The soil, humus-rich sandy matter (2Ab), sample 'DP-M-18e-67 (299 cm depth)' was enclosed in a Chernozem soil in dune sand. The paleosols were separated by thin sand layers. This dated paleosol overlies GSC-696 in the same section.

The 2 sigma calibrated age range is 1707 (1868) 1993.

GSC-969 Carberry II

normalized age: 2420 ± 140
$\delta^{13}C$= -21.0‰
uncorrected age: 2350 ± 140

The soil, humus-rich sandy matter (3Ab), sample 'DP-M-18c-67 (320 cm depth)' was enclosed in a Chernozem soil in dune sand.

The 2 sigma calibrated age range is 2333 (2360 2394 2420 2428) 2739.

Comment (P.P. David): The paleosols were separated by thin sand layers. Sample preparation was the same as for 'Brookdale Road' series. Contamination of GSC-969, by humus from younger paleosol, may have rendered it younger than true age of burial. GSC-969 agrees with GSC-817 and -981, GSC-579 and S-284 or -285 (cf. McCallum and Wittenberg, 1968). The dated paleosol GSC-969 underlies GSC-970 in the same section. GSC-970 agrees with GSC-898 (cf. Lowdon and Blake, 1970) and S-164 (cf. McCallum and Wittenberg, 1968). Both soils were buried by renewed eolian activity. See GSC-949 and -1091 (below, p. 12) for additional comments.

Carberry Series II

A series of samples, bone and paleosols, from a roadcut along north side of the Trans-Canada Highway in the Brandon Sand Hills, 7.2 km east of the junction with highway 258 south to Carberry, southwestern Manitoba (49°54'05"N, 99°15'30"W), at an elevation of about 385 m, was collected by P.P. David on August 19, 1967. These samples were submitted by P.P. David to gain information on eolian activity, climate change, and paleobiology.

GSC-990 Carberry III

normalized age:	1260 ± 130
	$\delta^{13}C$= -19.1‰
uncorrected age:	1170 ± 130

The bone (3 vertebrae of *Bison*; identified by C.R. Harington), sample 'DP-M-25c-67' from 244 cm depth was enclosed in dune sand overlying a Chernozem soil, paleosol (2Ab).

The 2 sigma calibrated age is 995 (1179 1210 1227) 1295.

Comment (P.P. David): The bone, apparently free of root hairs, dates renewed eolian activity and confirms the date of the immediately underlying paleosol (GSC-931).

GSC-931 Carberry IV

normalized age:	1200 ± 140
	$\delta^{13}C$= -25.5‰
unocrrected age:	1200 ± 140

The soil, humus-rich sandy material (2Ab), sample 'DP-M-256-67' from 256 cm depth was enclosed in a Chernozem soil in dune sand, the Ah horizon of upper of 2 paleosols. The bulk soil sample was freed from root hairs prior to dating.

The 2 sigma calibrated age is 956 (1091 1108 1135 1160 1168) 1286.

Comment (P.P. David): The agreement between ages of stratigraphically related materials is excellent, considering that sand enclosing bones contained humic matter reworked from an underlying paleosol. The bone could possibly be contaminated by older humic matter. The age of the bones (GSC-990) suggests they probably belonged to *Bison bison bison* (C.R. Harington, personal communication). These samples date renewed eolian activity.

GSC-774 Douglas Station East

uncorrected age:	1290 ± 130

The soil, humus-rich sandy matter (2Ab horizon), was enclosed in the lower of two buried Chernozem soils. Sample M-2b-66 from 396 cm depth was collected by P.P. David in 1966, from a roadcut through a stabilized dune in the Brandon Sand Hills along the north side of the Trans-Canada Highway, Douglas Station East, 14.4 km west of the junction with highway 258 leading south to Carberry, southwestern Manitoba (49°54'05"N, 99°34'05"W), at an elevation of about 385 m. This sample was submitted by P.P. David to gain information on dune formation.

Comment (P.P. David): The date represents mean residence time (M.R.T.) of the total soil humus of the sampled soil layer at the time of burial (Campbell et al., 1967a, b). The date should give the age of burial of the paleosol by renewed eolian activity, however the date may be slightly younger than the age of burial because of possible contamination by younger soil humus from the upper paleosol (undated) lying about 20 cm above the dated horizon (see Scharpensee et al., 1968, p. 10-11). The date overlaps GSC-990 and -931, 1260 ± 130 and 1200 ± 140 years, respectively (Lowdon, et al., 1971, p. 283) from Carberry northeast, which date one period of dune activity, and GSC-953, 1510 ± 150 years (Lowdon, et al., 1971, p. 283) from Brookdale Road, which dates an earlier period of dune activity (cf. David, 1971). GSC-774 probably dates the latter period, assuming that contamination from above has occurred.

Harte Road Series

A series of soil samples, humus-rich sandy matter from Ah horizon of 2 to 3 buried Chernozem soils exposed in 2 roadcuts through same wing of a stabilized dune in the Brandon Sand Hills, was collected from the western roadcuts along the road to Harte, 0.88 km north of Trans-Canada Highway, 8 km west of junction with highway 258 to Carberry, southwestern Manitoba (49°54'35"N, 99°28'35"W), at an elevation of about 385 m, by P.P. David in 1966 and on August 17, 1967. These samples were submitted by P.P. David to gain information on eolian activity and climate change.

GSC-976 Harte Road I

normalized age:	890 ± 130
	$\delta^{13}C$= -21.7‰
uncorrected age:	830 ± 130

The soil, humus-rich sandy matter of 2Ab horizon (DP-M-19b-67) from 130 cm depth was enclosed in a Chernozem soil in dune sand.

The 2 sigma calibrated age is 673 (789) 932.

This dated paleosol overlies GSC-817 and -891 in the same section.

GSC-817 Harte Road II

uncorrected age:	2320 ± 160

The soil, humus-rich sandy material of a 3Ab horizon (M-7-66) from 213 cm depth was enclosed in a Chernozem soil in dune sand. The paleosols of this section were buried by humus-free dune sand.

The 2 sigma calibrated age is 2131 (2344) 2709.

GSC-981 Harte Road III

normalized age:	2530 ± 140
	$\delta^{13}C$= -21.8‰
uncorrected age:	2480 ± 140

The soil, humus-rich sandy matter of 3Ab horizon from 265 cm depth was enclosed in a Chernozem soil in dune sand.

The 2 sigma calibrated age is 2356 (2713) 2775.

Comment (P.P. David): The preparation of GSC-976 and -981 were the same as for 'Brookdale Road' series. GSC-817 was based on a bulk soil sample cleaned of plant roots. GSC-981 and -817, from stratigraphically the same paleosol on opposite sides of the road, closely agree. GSC-981 is considered more reliable as contamination by humus from younger paleosol (not dated) directly overlying GSC-817 may have rendered the latter somewhat younger. Overlap of GSC-817 (uncorrected age only) with GSC-950 does not indicate age agreement since uncontaminated GSC-981 is beyond the age range of GSC-950. GSC-817 underlies GSC-976 which agrees with GSC-954 and S-286 (cf. McCallum and Wittenberg, 1968). GSC-981 and -817 agree with GSC-969, -579 and S-284 or -285 (cf. McCallum and Wittenberg, 1968). The soils were buried by subsequent dune activities resulting from extended periods of drought. See GSC-1091 (below) for additional comments.

Brookdale Road (west side) A Series

A series of paleosols from the 'Brookdale Road Site' (David, 1971), the southern section of the northern arm of a parabolic dune on the west side of the road in the Brandon Sand Hills, southwestern Manitoba (49°55'24"N, 99°35'38"W), at an elevation of 366 m, was collected by S.A. Wolfe and D.R. Muhs on June 12, 1997. The humic extract of these samples was submitted by D.R. Muhs to gain information on eolian (dune) stability and to crosscheck previous dates (GSC-954 and -949, below, respectively).

CAMS-30732 Brookdale Road I

normalized age: 920 ± 150

The humic extract of sample MB-20-2Ab from 75 cm depth was enclosed in a 2Ab paleosol in sand dune.

The age was normalized assuming a $\delta^{13}C$ of -25‰. The 2 sigma calibrated age is 562 (794 812 827 864 889) 1171.

CAMS-30733 Brookdale Road II

normalized age: 4180 ± 75

The humic extract of sample MB-20-5Ab from 235 cm depth was enclosed in 5Ab paleosol in sand dune.

The age was normalized assuming a $\delta^{13}C$ of -25‰. The 2 sigma calibrated age is 4449 (4659 4666 4711 4718 4730 4754 4815) 4866.

General comment (S.A. Wolfe): The Brandon Sand Hills area of southwestern Manitoba is the northeasternmost dune field on the northern Great Plains. At present, it is mostly stabilized by vegetation. However, accelerator mass spectrometry and bulk radiocarbon age determinations of organic matter from paleosols within the shallow stratigraphic sections indicate that this dune field has been subjected to recurrent intervals of eolian activity several times in the past 5000-6000 years. Although precise regional correlations are precluded by dating uncertainties, there were several periods of notable paleosol development around 4-5 ka; 2.1 ka (ranging from 1.7 to 3.8 ka); 1.1-1.6 ka; and 0.5-0.6 ka cal BP with eolian activity occurring before and after each of these periods.

The geochemistry of the eolian sands, paleosols and source sediments indicates that partial leaching of carbonates occurred during pedogenesis, and that this is probably the primary mechanism of carbonate depletion of eolian sands in this area. This contrasts with the Minot dune field in adjacent North Dakota, where carbonate depletion appears to result from abrasion during periods of eolian activity. The lack of carbonate depletion by eolian abrasion suggests that, throughout the Holocene, the Brandon Sand Hills may have been less active than the Minot dune field. Recent trends in sand dune activity, as judged from historic aerial photography and early explorers' accounts, indicate that the few active dunes that presently exist have stabilized at a rate of 10-20% per decade, despite several severe droughts in the 20th century. The present dune stability may be related, in part, to the spread of forest cover in the area in the past few hundred years.

Brookdale Road (east side) Series

A series of paleosol samples from the east side of the road to Brookdale in the Brandon Sand Hills, 2.25 km north of the Trans-Canada Highway about 8 km east-northeast of Douglas Station, southwestern Manitoba (49°55'25"N, 99°35'25"W), at an elevation of 385 m, was collected by P.P. David in 1970. These samples were submitted by P.P. David to gain information on eolian processes, and climate change, especially periods of drought.

QU-1378 Brookdale Road (east side) I

normalized age: 2690 ± 170

The soil, humus-rich sand of 3Ab horizon (M-4D-70 #3) from 140 cm depth was enclosed in a Chernozem soil in dune sand.

The age was normalized assuming a $\delta^{13}C$ of -27‰. The 2 sigma calibrated age is 2350 (2777) 3244.

QU-1377 Brookdale Road (east side) II

normalized age: 2950 ± 160

The soil, humus-rich sand of 4Ab horizon (M-4B-70 #4) from 160 cm depth was enclosed in a Chernozem soil in dune sand.

The age was normalized assuming a $\delta^{13}C$ of -27‰. The 2 sigma calibrated age is 2752 (3079 3091 3105 3128 3138 3151 3156) 3472.

Comment (P.P. David): This site is south and across the road from the 'Brookdale Road Section' in the south wing of a parabolic dune. The surface soil was covered by freshly blown sand. Four Ah horizons were present at the site. The three paleosols are separated by dune sand that contains some humus. The dispersed nature of the humus suggests that it most likely originated through the pedological process of downward migration from the soil above and NOT blown in with the sand. These sand beds are strongly mottled, patchy grey and lighter yellow grey. The buried zones converge eastward, i.e. into the section.

Stratigraphy:

000-011 cm	freshly blown sand with very sharp basal contact;
011-018 cm	'recent' Ah zone (#1);
018-110 cm	upper part (15-20cm) is little oxidized (B horizon), the rest is clean dune sand with a sharp basal contact;
110-125 cm	Ahb horizon (#2) with a transitional basal contact;
125-133 cm	mainly unoxidized dune sand with a transitional basal contact;

133-148 cm	paleosol sampled at 140cm (M-4D-70 is QU-1378) Ahb (#3); this unit was poorest in humus; basal contact transitional;
148-158 cm	mainly unoxidized with a transitional basal contact;
158-163 cm	paleosol sampled at 160cm (M-4B-70 is QU-1377) Ahb (#4); this unit was richest in humus; basal contact sharp;
163-240 cm	upper part was minimally oxidized (Bh horizon) dune sand with a very sharp basal contact;
240-260 cm	deltaic gravel deposit.

Brookdale Road (west side) B Series

A series of paleosol samples from west side of the road to Brookdale (Brandon Sand Hills) 2.56 km north of the Trans-Canada Highway about 8 km east-northeast of Douglas Station, southwestern Manitoba (49°55'30"N, 99°35'25"W), at an elevation of 385 m, was collected by P.P. David on August 16, 1967 and by L.A. Jaskula in 1968. These samples were submitted by P.P. David to gain information on dune formation, and climate change, specifically periods of drought.

GSC-1091 Brookdale Road (west side) III

normalized age:	430 ± 130
	$\delta^{13}C$= -19.3‰
uncorrected age:	340 ± 130

The soil, humus-rich sand of 2Ab horizon from 52 cm depth was enclosed in a Chernozem soil in dune sand.

The 2 sigma calibrated age is 313 (505) 548.

GSC-954 Brookdale Road (west side) IV

normalized age:	920 ± 140
	$\delta^{13}C$= -18.4‰
uncorrected age:	820 ± 140

The soil, humus-rich sand of 2Ab horizon (DP-M-17k-67) from 73 cm depth was enclosed in a Chernozem soil in dune sand.

The 2 sigma calibrated age is 686 (794 812 827 864 889) 961.

GSC-953 Brookdale Road (west side) V

normalized:	1510 ± 150
	$\delta^{13}C$= -22.9‰
uncorrected age:	1480 ± 150

The soil, humus-rich sand of 3Ab horizon (DP-M-17i-67) from 128 cm depth was enclosed in a Chernozem soil in dune sand.

The 2 sigma calibrated age is 1288 (1392 1401 1406) 1545.

GSC-950 Brookdale Road (west side) VI

normalized age:	2150 ± 150
	$\delta^{13}C$= -22.9‰
uncorrected age:	2120 ± 150

The soil, humus-rich sand of Ah horizon (DP-M-17g-67) from 182 cm depth was enclosed in a Chernozem soil in dune sand.

The 2 sigma calibrated age is 1933 (2125 2139 2146) 2341.

GSC-949 Brookdale Road (west side) VII

normalized age:	3680 ± 180
	$\delta^{13}C$= -27.0‰
uncorrected age:	3710 ± 180

The soil, humus-rich sand of 5Ab horizon (DP-M-17e-67) from 235 cm depth was enclosed in a Chernozem soil in dune sand.

The 2 sigma calibrated age is 3727 (3985 4050 4060) 4257.

Comment (P.P. David): Humus-rich sand from the Ah horizons of 5 buried Chernozem soils were exposed in a roadcut through the north wing of a stabilized dune of Brandon Sand Hills along the road (west side) to Brookdale. Paleosols separated by beds of humus-free sands occur in about 2.8 m of dune sand overlying sediments of Assiniboine delta of Lake Agassiz (Elson, 1960).

The samples were collected to date Holocene eolian activity and to trace past periods of drought. Dunes of the area were periodically active over the past 3.7 ka rcybp or more. The radiocarbon dates indicate the periods of dune inactivity, when the moisture content was high enough to allow soils to form. During drought, the moisture content of the dunes and underlying deltaic sediment were so low that the stabilizing vegetation died and, in places, the soils were buried by wind-blown sand. The dates of this series represent mean residence time of total soil humus of the sampled soil layer at the time of soil burial.

General comment on series (P.P. David): The samples were not chemically pre-treated prior to dating, consequently the dates represent mean residence time (M.R.T.) of total soil humus of the sampled soil layer at the time of soil burial (Campbell et al., 1967b). The dates may be slightly older than soil burial, but since all samples, except GSC-949 (5 cm below the top of the paleosol), were from the upper 2 to 3 cm of the paleosols, the age discrepancy should be small (Lowdon and Blake, 1968). The soils were buried by subsequent dune activity produced by extended periods of drought (David, 1971).

GSC-954 agrees with GSC-976 (Lowdon, et al., 1971) and S-286 (McCallum and Wittenberg, 1968); GSC-953 with GSC-761 (Lowdon and Blake, 1968) and S-45 (McCallum and Dyck, 1960). GSC-950 overlaps with GSC-817 and -969 (Lowdon, et al., 1971) and -579 (Lowdon et al., 1967); however, it dates a younger episode of dune building (cf. GSC-817).

QU-1287 Wellwood

normalized age:	1310 ± 330

The soil, humus-rich sand of a 2Ab horizon, was enclosed in a Chernozem soil in dune sand. Sample M-8B-70 from 45 cm depth was collected by P.P. David in 1970, from the north side of highway 258 in the Brandon Sand Hills, east of the junction of highways 258 and 353, and east of Wellwood, southwestern Manitoba (50°02'00"N, 99°15'55"W), at an elevation of 387 m. This sample was submitted by P.P. David to gain information on eolian activity, and periods of drought.

The age was normalized assuming a $\delta^{13}C$ of -27‰. The 2 sigma calibrated age is 571 (1263) 1922.

Comment (P.P. David): The roadcut is on the western edge of a contiguous dune area at the top of a scarp that descends to the dunes on the north side of highway that crosses the dune area to the big escarpment at Edrans. The soil is buried by eolian cliff-top sand. Both the surface and buried soil have B horizons. The eolian

sediment is loess. Eastward the loess thickens a little but disappears over the scarp which must have been cut after the loess formed. In the scarp lacustrine (deltaic) silt comes to the surface forming a break on the slope.

Stratigraphy:

000-014 cm	compact Ah horizon;
014-039 cm	B horizon with a sharp basal contact; hard near top and looser lower down but still stands vertically;
039-048 cm	Ahb horizon -sample taken from 45 cm depth;
048-065 cm	oxidized, well developed, compact Bb horizon;
065-120 cm	olive yellow silt (loess), looser than above but still stands vertically in the cut;
120-130 cm	poorly oxidized, grey-brown to brown-grey lacustrine silt;
130-150+cm	pale olive grey stratified sand, lacustrine silt, unoxidized.

QU-1286 Wellwood

normalized age: 1370 ± 100

The soil, humus-rich sand of a 9Ab horizon, was enclosed in a Chernozem soil in dune sand. Sample M-6B-70 from 220 cm depth was collected by P.P. David in 1970, from the south side of the highway 258 in the Brandon Sand Hills, 1.12 km from CNR rail crossing, about 5.6 km west of Wellwood and 3.5 km west and 14.48 km north of the intersection of the highway to Carberry and the Trans-Canada Highway, southwestern Manitoba (50°02'00"N, 99°24'45"W), at an elevation of 390 m. This sample was submitted by P.P. David to gain information on eolian processes, i.e. drought, and to date the geoarchaeology material.

The age was normalized assuming a $\delta^{13}C$ of -27‰. The 2 sigma calibrated age is 1062 (1290) 1509.

Comment (P.P. David): The roadcut is in a 'lonely dune' overlying deltaic deposits. There are seven 1-4 cm-thick Ah horizons or humic material blown into place, above the sampled horizon. The sampled horizon (220cm) was thick and clearly merges with the present-day surface soil. Some broken arrow heads and one larger chipped stone were picked up from the exposure just below the thick Ahb horizon.

Stratigraphy:

000-030 cm	freshly blown sand with a sharp basal contact;
030-215 cm	dune sand with sharp basal contact and organic horizons at: 50-52, 81-82, 117-120, 133-135, 140-142, 155-157. Some of these are 4 cm thick elsewhere;
215-265 cm	Ahb horizon with gradational basal contact to oxidized Bh horizon; Sample M-6B-70 taken at 220 cm depth;
265-455+cm	base of dune sand not reached

QU-1429 Edrans

normalized age: 1090 ± 90

The soil, humus-rich sand (2Ab horizon), was enclosed in a Chernozem soil in dune sand. Sample M-9B-70 from 170 cm depth was collected by P.P. David in 1970, from a roadcut on the south side of highway 353, west of Edrans, southwestern Manitoba (50°20'13"N, 99°13'50"W), at an elevation of 372 m. This sample was submitted by P.P. David to gain information on eolian processes, and periods of drought.

The age was normalized assuming a $\delta^{13}C$ of -27‰. The 2 sigma calibrated age is 792 (971) 1256.

Comment (P.P. David): A roadcut which appears to be at the head of a small dune was sampled.

Stratigraphy:

000-010 cm	Ah horizon under vegetation;
010-170 cm	dune sand; sampled at 170 cm depth;
170-184 cm	Ahb horizon which rises westward in the roadcut;
184-230+cm	dune sand

CAMS-44526 Berens River

normalized age: modern

The raspberry seeds (*Rubus idaeus* L.; identified by A.M. Telka) were enclosed in a paleosol. Sample 97301-007 was collected by D.L. Forbes and L. Hopkinson on March 22, 1997, from north of the Berens River, off Disbrowe Point in the north basin of Lake Winnipeg, Manitoba (52°24.92'N, 97°06.94'W), at an elevation of 220 m. The buried soil horizon in the dunes on the neck of Disbrowe Point was about 2.4 m above lake-ice level. This sample was submitted by D.L. Forbes to gain information on the onshore beach, and the dune formation.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Comment (D.L. Forbes): The modern date on this sample demonstrates that dune migration on the lakeward half of the Disbrowe Point 'spit' at its narrowest part has been active in recent time. The driftwood ages from the face of the dune in this vicinity (see BGS-1910 and -1911, p. 87 and 88) show that washover trimmed the dune in at least one place here within the past 130 radiocarbon years.

Fossil Arthropod and Plant Macrofossil Report: 98-04 (A.M. Telka)
Sample No.: 97301-007
Laboratory No.: 2-113
Material: sand with organics
Sample Vol.: 125 mL

PLANT MACROFOSSILS:

Fungal Remains:	
fungal sclerotia	+ 16
Vascular Plants:	
Equisetaceae ...."horsetail family"	
Equisetum sp.	+ large stem fragment: 1
Typhaceae....."cat-tail family"	
Typha sp.	+ seeds: 2
Gramineae? ....."grass family"	+ seed: 1
Cyperaceae ....."sedge family"	
Carex trigonous type	+ seeds: 2
Carex lenticular type	+ seeds: 2
Chenopodiaceae .."goosefoot family"	
Chenopodium sp.	+ seeds: 1.5
Rosaceae ....."rose family"	
Potentilla spp.	+ seeds: 2
Rubus idaeus L.	+ seeds: 2.5
Umbelliferae ...."parsley family"	
Cicuta sp.	+ seed: 1, seed fragments: 3
Ericaceae ....."heath family"	
Chamaedaphne calyculata (L.) Moench.	+ seed: 1
Primulaceae ....."primrose family"	
Lysimachia sp.	+ seeds: 4

Gentianaceae ...."gentian family"		
Menyanthes trifoliata L.	+	seeds: 4.5
Lentibulariaceae "bladderwort family"		
Pinguicula? sp.	+	seed: 1
Unidentified plant taxa	+	unknown seeds: 3 (three types); seed fragments: 5
Other:		
wood	+	many large pieces, charred wood (worn): 2, twigs: few
charcoal	+	fragments: 4
ANIMAL MACROFOSSILS:		
BRYOZOA		
Cristatella mucedo L.	+	statoblast: 1
ARTHROPODA		
INSECTA		
HEMIPTERA ....."bugs"		
Pleidae....."small backswimmers"		
Plea striola Fieber	+	head: 1
COLEOPTERA ....."beetles"	+	elytra: 2
Staphylinidae ..."rove beetles"		
Lathrobium sp.	+	head: 1
Scarabaeidae ...."scarab beetles"	+	articulated legs: 4
Curculionidae ..."weevils"		
Sitona sp.	+	head: 1
DIPTERA ....."flies"	+	puparial fragments: 5 (many different types)
ARACHNIDA		
Oribatei/Acari .."mites"	+	6

Key: + = taxon present, +++ = taxon is abundant
-based upon examination of organics greater than 250 microns (0.25 mm)

Reader Lake Series

A series of samples from the southeast shore of Reader Lake, 15 km northwest of The Pas, Manitoba (53°53'N, 101°19'W) was collected by E. Nielsen on July 16, 1987. These samples were submitted by E. Nielsen to gain information on dune formation, and dune stabilization.

BGS-1205 (1) Reader Lake I

uncorrected age: modern

The wood sample 'TP-106' was enclosed in calcareous sand.

BGS-1205 (2) Reader Lake II

uncorrected age: modern

The wood sample 'TP-106' was enclosed in calcareous sand.

BGS-1209 Reader Lake III

uncorrected age: 4150 ± 80

The organic sand, paleosol, sample 'D (ii)' was enclosed in calcareous sand about 7.0 m above the floor of a newly dug pit in stabilized sand dune.

BGS-1210 Reader Lake IV

uncorrected age: 5300 ± 90

The organic sand, paleosol, sample '14 (i)' was enclosed in calcareous sand about 6.6 m above the floor of a newly dug pit in stabilized sand dune.

BGS-1211 Reader Lake V

uncorrected age: 5830 ± 90

The organic sand, paleosol, sample '5 (ii)' was enclosed in calcareous sand about 1 m above the floor of a newly dug pit in stabilized sand dune.

Baldock Lake Series

A series of wood samples from a natural blow-out in sand dunes at Baldock Lake, 80 km north of Thompson, Manitoba (56°32'N, 97°57'W) was collected by E. Nielsen on June 15, 1981. These samples were submitted by E. Nielsen to gain information on eolian processes.

BGS-819 Baldock Lake I

uncorrected age: 400 ± 100

The wood sample (Th-011(c)) was enclosed in sand.

BGS-818 Baldock Lake II

uncorrected age: 430 ± 100

The wood sample (Th-011(b)) was enclosed in sand.

Radiocarbon Dates related to Hydrology (Fig. 4)

Max Lake Series

A series of samples from Max Lake on the Turtle Mountain Upland, about 20 km south of Boissevain, southwestern Manitoba (49°04'N, 100°09'W), at an elevation of 671 m, was collected by R.E. Vance and D.S. Lemmen on March 20, 1993. Core 'MX1' was sampled with vibracore from a winter ice platform in 3.06 m of water and ice, whereas core 'MX2' (field label 'MX3') was taken with a vibracore from a winter ice platform with only 2.19 m of water and ice. These samples were submitted by R.E. Vance to gain information on climate change, and paleohydrology.

CAMS-12908 Max Lake I

normalized age: 1740 ± 50

The calyx and seeds (*Rumex maritimus*, and *Erigeron*-type; identified by R.E. Vance) from 250-255 cm depth in core 'MX1' were enclosed in silty clay lake sediment. All macrofossils were in excellent condition, indicating little chance that they were re-deposited.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

CAMS-8368 Max Lake II

normalized age: 3330 ± 70

The seeds (*Scirpus* cf. *americanus*; identified by R.E. Vance) from 365-370 cm depth in core 'MX1' were enclosed in silty clay lake sediment. The seeds were rounded with smoothed surfaces and had no bristles.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Comments (R.E. Vance): The age may be anomalously old, since both *Scirpus* seeds show signs of re-deposition.

CAMS-45365 Max Lake III

normalized age: 3330 ± 150

The seeds (*Rumex maritimus, Lycopus americanus, Potentilla anserina, Chenopodium salinum*; identified by R.E. Vance) from 220-225 cm depth in core 'MX2' were enclosed in silty clay lake sediment (massive mud). They were all in good condition.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

CAMS-25806 Max Lake IV

normalized age: 3820 ± 60

The seed (*Scirpus* cf. *americanus*; identified by R.E. Vance) from 250-254 cm depth in core 'MX2' was enclosed in silty clay lake sediment. The seed was in good condition with 1 small bristle and a portion of the distal tip present.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

CAMS-25804 Max Lake V

normalized age: 4030 ± 60

The seed (*Scirpus* cf. *americanus*; identified by R.E. Vance) from 280-282.5 cm depth in core 'MX2' was enclosed in silty clay lake sediment. The seed was in good condition with 1 bristle and a portion of the distal tip present.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

CAMS-25805 Max Lake VI

normalized age: 4050 ± 60

The seed (*Scirpus* cf. *americanus*; identified by R.E. Vance) from 268-270 cm depth in core 'MX2' was enclosed in silty clay lake sediment. The seed was in good condition with 2 bristles and most of the distal tip present.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Killarney Lake Series

A series of samples from Killarney Lake, about 3 km from Killarney, southwestern Manitoba (49°11'N, 99°42'W), at an elevation of 490 m, was collected by R.E. Vance and D.S. Lemmen on March 21, 1993. Core 'KL1' was taken with a vibracore from a winter ice platform with 6.0 m of water and ice. These samples were submitted by R.E. Vance to gain information on climate change, and paleohydrology.

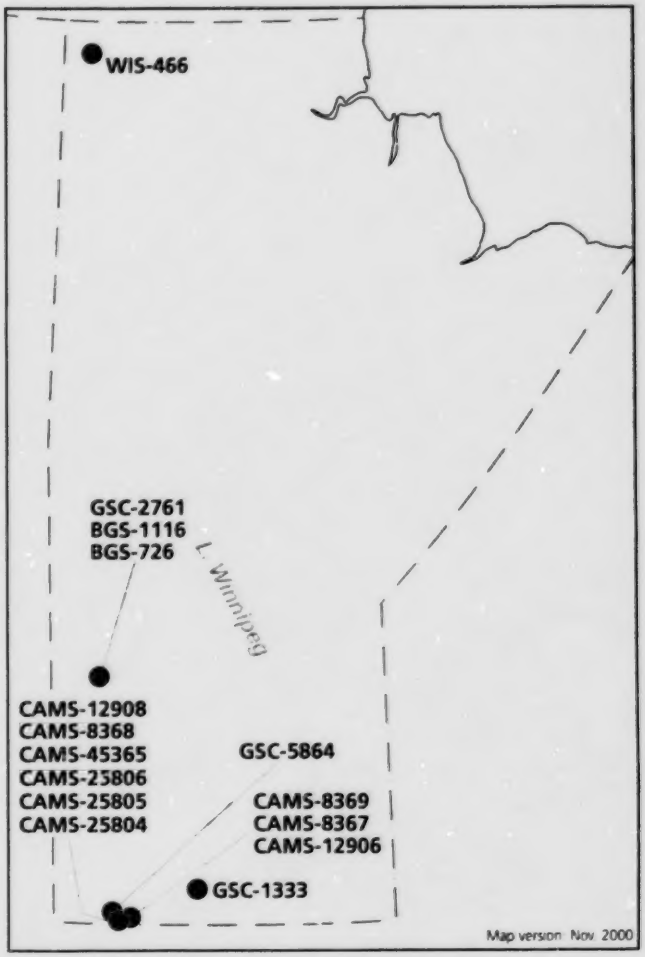

Figure 4. Radiocarbon dates related to hydrology.

CAMS-12906 Killarney Lake I

normalized age: 1520 ± 50

The seed (*Scirpus* cf. *americanus*; identified by R.E. Vance) from 110-115 cm depth in core 'KL1' was enclosed in mud. The seed was in good condition, a few bristles remaining, but not pristine.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

CAMS-8367 Killarney Lake II

normalized age: 6090 ± 70

The seed and calyx (*Scirpus* cf. *americanus* and *Rumex maritimus*; identified by R.E. Vance) from 305-310 cm depth in core 'KL1' were enclosed in mud. They were in pristine condition, indicating little chance of re-deposition.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

CAMS-8369 Killarney Lake III

normalized age: 9180 ± 80

The seeds (*Scirpus* cf. *americanus*; identified by R.E. Vance) from 355-360 cm depth in core 'KL1' were enclosed in mud. The seeds were in poor condition, suggesting that they were re-deposited.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Comments (R.E. Vance): This date could be anomalously old.

GSC-5864 Zetterstrom Creek

normalized age: modern
$\delta^{13}C$= -28.3‰

The wood (*Ulmus* cf. *U. americana*; identified by R.J. Mott in unpublished GSC Wood Report No. 96-61) was enclosed in poorly stratified silty sand under 75 cm of organic-rich mucky sandy silt. Sample '94-FI-017' from 100 cm depth was collected by R.J. Fulton on June 9, 1994, from Zetterstrom Creek, 5 km south of Whitewater Lake, 10 km south of Boissevain, Manitoba (49°11'30"N, 100°10'30"W), at an elevation of 512 m. This sample was submitted by R.J. Fulton to gain information on climate change, and paleohydrology.

Comment (R.J. Fulton): The field exposure was poor so it is possible that the wood was part of a modern root, or that a stream bank collapse had caused organic-rich muck to slump over the modern sediments containing the wood.

GSC-1333 Somerset Pond

uncorrected age: 5310 ± 150

The organic detritus was enclosed in 0.6 m of gyttja which was deposited over 2.8 m of unoxidized lacustrine clay, over glacial till. Sample '16-89-69' from 182.8-185.6 cm depth was collected by L.D. Delorme in July 1969, from Somerset Pond, about 6 km southeast of Somerset, Manitoba (49°23'N, 98°37'W), at an elevation of about 490 m. This sample was submitted by L.D. Delorme to gain information on climate change, and paleohydrology.

Comment (L.D. Delorme): Analysis of shelled invertebrates (ostracodes) from the unit, which includes the sampled interval, indicates a highly eutrophic lake (Delorme, 1971). Paleolimnological and paleoclimatic interpretations derived from the sediments lower in this core are correlated with the fluctuating ice margin within the Agassiz Basin.

Sclater Series

A series of samples from 2 km east of Sclater, Manitoba (51°55.7'N, 100°34.0'W), at an elevation of 340 m, was collected by E. Nielsen on July 10, 1978 and August 24, 1979. These samples were submitted by E. Nielsen to gain information on climate change, a dry interval (drought), and fan inactivity.

BGS-1116 Sclater I

uncorrected age: 225 ± 75

The spruce wood sample 'EN-257' from 1.5 m depth was a stump rooted in a fresh exposure of calcareous silt about 0.2 m above a paleosol.

GSC-2761 Sclater II

uncorrected age: 840 ± 50

The organic detritus sample (E.N.-1978), taken from 1.7 m below the surface, was enclosed in a 5 cm-detritus layer from a peaty horizon about 0.3 m below the base of a tree-stump horizon buried in the alluvium. Both the peaty horizon and the overlying tree-stump horizon were exposed for a distance of about 1 km along the length of the 4.5 m-high alluvial fan section.

BGS-726 Sclater III

uncorrected age: 3830 ± 125

The peaty sand sample (EN-257 (d)), 2.7 m below surface, was enclosed in silty sand in a well drained sand and silt of a fresh exposure along Sclater River.

Comment (E. Nielsen): Assuming that the fan is built on a nearly horizontal till surface, calculations based on the slope of the surface and the approximate extent of the fan indicate that the deposit is at most 6 m-thick at the sampling site. Extrapolation based on the sedimentation rate indicates the fan is therefore not more than 3000 years old. The initiation of the formation of the fan is tentatively correlated with the increase in precipitation in the area between 2500 and 3500 years ago (Bryson and Wendland, 1967; Ritchie, 1969). The organic-rich horizon marks a pronounced disconformity in the alluvial fan sequence and probably represents a period of reduced precipitation in the area. The date and its paleoclimatic implications do not substantiate the conclusion by David (1971) that paleosols in the Brandon Sand Hills, 235 km south of Sclater, dated at 920 ± 140 years and 890 ± 130 years, (GSC-954 and -976, respectively; Lowdon et al., 1971, p. 283-284) represent a time of increased precipitation.

Comments (W. Blake., Jr.): The age determinations on humus-rich sands reported by David (1971, p. 297) represent 'the mean residence time (M.R.T.) of the total soil humus of the sampled soil layers at the time of burial of the soils. All the radiocarbon ages should be treated as maximum ages for the time of burial of the soils.' Thus there may not be a conflict in interpretation, especially when the error term on the ages is taken into account. It is also worth noting that plant remains present in the organic detritus included achenes of *Carex*, a fragment of achenes of *Rubus*, and an achene of *Ranunculus*, cf. *R. sceleratus* L. - the latter plant 'usually grows on the seasonably flooded, muddy margins of small ponds'. The presence of water is also suggested by fragments of an unidentified hydrophilid beetle (unpublished GSC Plant Macrofossil Report No. 78-8 by J.V. Matthews, Jr.).

WIS-466 Kasmere Lake

uncorrected age: 1265 ± 55

The charcoal was enclosed in a paleosol (buried soil) near the base of an esker. The sample from 15 cm below surface was collected by C.J. Sorenson in 1970, from Kasmere Lake area, Manitoba (59°40'N, 101°14'W). This sample was submitted by C.J. Sorenson to gain information on forest development.

Radiocarbon Dates on Pollen Profiles (Fig. 5)

Shoofly Lake Series

A series of lake sediment samples from Shoofly Lake, 3.4 km north of U.S.A. border just east of highway 10 in Turtle Mountain Provincial Park, southwestern Manitoba (49°01'45"N, 100°02'54"W), at an elevation of 693.6 m, was collected by J.C. Ritchie in 1969. The water depth was 3 m. These samples were submitted by J.C. Ritchie to gain information on the pollen spectra.

I-4276 Shoofly Lake I

uncorrected age: 1210 ± 125

The lake sediment sample from 100 cm depth was enclosed in mud.

I-4274 Shoofly Lake II

uncorrected age: 5300 ± 140

The lake sediment sample from 360 cm depth was enclosed in mud.

I-4273 Shoofly Lake III

uncorrected age: 6369 ± 115

The lake sediment sample from 440 cm depth was enclosed in mud.

I-4272 Shoofly Lake IV

uncorrected age: 10 140 ± 170

The lake sediment sample from 520 cm depth was enclosed in mud.

Glenboro Series

A series of lake sediment samples from a small 3 m-deep kettle lake, 12 km south of Glenboro, Manitoba (49°26'N, 99°17'W) was collected by J.C. Ritchie in 1964. These samples were submitted by J.C. Ritchie to establish the chronology of the main pollen assemblage zones for the Holocene.

I-1511 Glenboro I

uncorrected age: 2430 ± 130

The lake sediment, gyttja sample, (depth unknown) was enclosed in non-laminated clay gyttja above clay.

Comment (J.C. Ritchie): The pollen indicates an 'oak savannah vegetation type'.

I-1512 Glenboro II

uncorrected age: 3200 ± 240

The lake sediment, gyttja sample, from 310-320 cm depth was enclosed in non-laminated clay gyttja above clay.

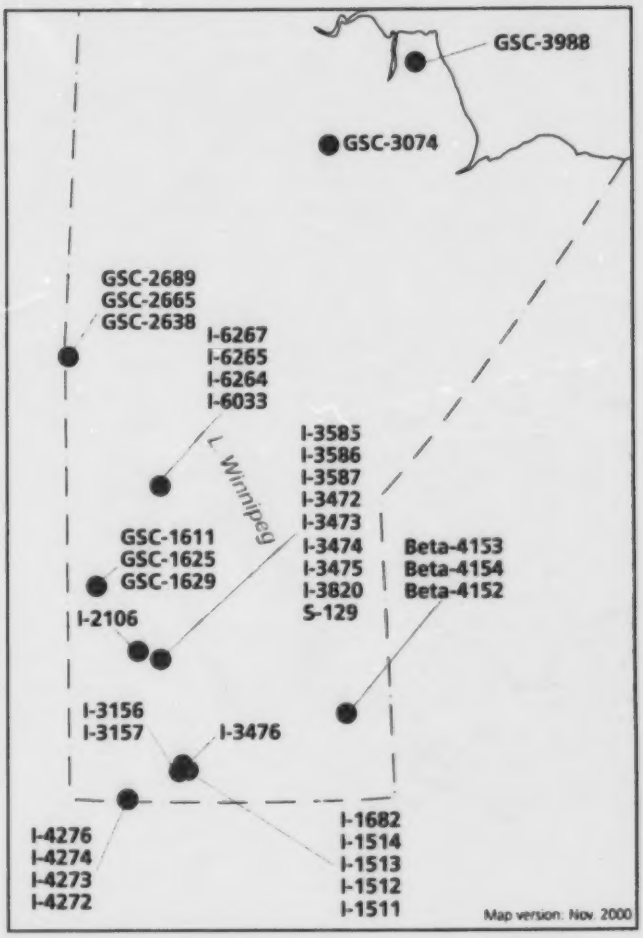

Figure 5. Radiocarbon dates providing chronologic control for pollen profiles.

I-1513 Glenboro III

uncorrected age: 4500 ± 250

The lake sediment, gyttja sample, from 445-455 cm depth was enclosed in non-laminated clay gyttja above clay.

I-1514 Glenboro IV

uncorrected age: 5220 ± 550

The lake sediment, gyttja sample, from 565-575 cm depth was enclosed in non-laminated clay gyttja with some *Chara* marl above clay.

Comment (J.C. Ritchie): The sample dates a zone that indicates 'either a grassland dominated landscape or a parkland' at this time.

I-1682 Glenboro V

uncorrected age: 12 800 ± 350

The lake sediment, basal gyttja sample, from 980-990 cm depth was enclosed in laminated gyttja near 'coarse detritus' at base of core laminae (couplets).

Comment (J.C. Ritchie): The 'high frequency of degraded pollen grains' suggests that this date may be contaminated by pre-Quaternary organic material and may be too old according to Teller. The date has been used to establish the latest presence of active glaciation in this region (Harris et al. 1974; Moran et al. 1976).

Belmont Series

A series of samples from a kettle lake near Belmont, Manitoba (49°26'N, 99°26"W) was collected by J.C. Ritchie in 1967. These samples were submitted by J.C. Ritchie to gain information on the pollen spectra.

I-3156 Belmont I

uncorrected age: 3570 ± 130

The freshwater mollusc shells, (sample BT 22), from 210-220 cm depth were enclosed in a 6 m-thick silty clay gyttja below a 1.5 m zone of coarse detritus with silt.

Comment (J.C. Ritchie): The date was at the transition from a pollen zone that is dominated by grass-herb pollen to an oak savannah vegetation type (oak-birch). This date was mistakenly reported as being from 195 cm depth in the original date list (Isotope VI / VII).

I-3157 Belmont II

uncorrected age: 9430 ± 160

The basal gyttja lake sediment, (sample BT 115), from 605-610 cm depth was enclosed in gyttja and overlain by 1.5 m of coarse detritus with silt.

Comment (J.C. Ritchie): The dated sample is from the transition of a spruce-pollen zone to a grassland zone.

I-3476 Sewell Lake

uncorrected age: 13 900 ± 240

The fine organic lake sediment was enclosed in organic limnic mud from a sand dune. The sample from about 4.4 m depth was collected by J.C. Ritchie, from Sewell Lake in the Epinette Creek valley of old Assiniboine River delta distributary channel, 26 km east of Brandon and 6 km northeast of Shilo, Manitoba (49°35'N, 99°15'W). This sample was submitted by J.C. Ritchie to gain information on the pollen spectra, and deglaciation.

Comment (J.C. Ritchie): The pollen spectrum shows the date to be from a spruce-dominated zone of the core.

Picket Lake Series

A series of lake sediment samples from Picket Lake, southeastern Manitoba (50°06'10"N, 95°43'45"W), at an elevation of 275 m, was collected by S. Kroker in March, 1981. These samples were submitted by S. Kroker to gain information on the Holocene pollen spectra and climate change.

Beta-4154 Picket Lake I

uncorrected age: 3930 ± 70

The lake sediment sample from 105-115 cm provided a bulk organic date on the sediment core interval.

Comment (S. Kroker): This date is anomalously old for the level in the core when compared to the two dated intervals lower in the core.

Beta-4153 Picket Lake II

uncorrected age: 3430 ± 70

The lake sediment sample from 190-198 cm provided a bulk organic date on the sediment core interval.

Beta-4152 Picket Lake III

uncorrected age: 5510 ± 90

The lake sediment sample from 260-271 cm provided a bulk organic date on the sediment core interval.

Comment (S. Kroker): These dates on Picket Lake were from a core taken for palynological analysis. The preliminary data were published in Kroker (1981). However, the radiocarbon dates had not been received by the time of publication, so they were not included in this publication. The dates and a final pollen diagram were presented as a conference paper (Kroker, 1982). Unfortunately the final report, including dates, has never been formally published, but in Buchner (1984a, p. 51) it is noted that 'Ritchie's (1976) synthesis of palaeoclimatic data for central Canada indicates a penetration of the grasslands to the north and east of about 150 km in the fifth millennium BC. There is little in the way of direct evidence for the precise date of the termination of this warm, dry phase locally, although a pollen study undertaken by S. Kroker (in Buchner 1981: 108-113) at Picket Lake in the Whiteshell Provincial Park pointed to the presence of grassland or parkland conditions to the southeast of the Sinnock site until the period of time correlative with the 220 cm below-surface level. The 260-271 and 190-198 cm levels were dated at 3560 BC ± 90 (Beta-4152) and 1480 BC ± 70 (Beta-4153), respectively.'

S-129 Wilson Creek Experimental Watershed

uncorrected age: 9570 ± 130

The basal wood (*Picea glauca*; identified by J.C. Ritchie) was enclosed in a 2.4 m-thick limnic peat overlying Valders drift, and underlying 2.7 m of terrestrial peat. The sample was collected by J.C. Ritchie in September, 1960, from Wilson Creek Experimental Watershed in Riding Mountain National Park, Manitoba (50°43'N, 99°38'W). This sample was submitted by J.C. Ritchie to gain information on the pollen spectra.

Comment (J.C. Ritchie): The peat has yielded a pollen diagram which, judging by this date, is post-Valders. Despite differences in percentage composition between vegetation and pollen spectrum, the vegetation is assumed to be similar to today's.

Riding Mountain Series

A series of lake sediment samples from a kettle lake on Riding Mountain, Manitoba (50°43'N, 99°39'W) was collected by J.C. Ritchie in 1968. These samples were submitted by J.C. Ritchie to gain information on the pollen spectra, i.e. vegetation succession.

I-3585 Riding Mountain I

uncorrected age: 775 ± 110

The organic debris from 15-20 cm depth was enclosed in fibrous organic debris / coarse gyttja / fine gyttja / clay-gyttja / stoney calcareous clay.

I-3586 Riding Mountain II

uncorrected age: 1170 ± 110

The organic debris from 40-45 cm depth was enclosed in loose fibrous organic debris above coarse gyttja.

I-3587 Riding Mountain III

uncorrected age: 1780 ± 110

The organic debris from 70-75 cm depth was enclosed in loose fibrous organic debris above coarse gyttja.

I-3820 Riding Mountain IV

uncorrected age: 5025 ± 120

The gyttja from 190-195 cm depth was enclosed in coarse gyttja below fibrous organic debris.

I-3472 Riding Mountain V

uncorrected age: 6130 ± 130

The gyttja from 230-235 cm depth was enclosed in coarse gyttja below loose fibrous organic debris.

I-3473 Riding Mountain VI

uncorrected age: 7280 ± 130

The gyttja from 270-275 cm depth was at the transition from underlying fine gyttja to overlying coarse gyttja.

I-3474 Riding Mountain VII

uncorrected age: 7750 ± 130

The gyttja from 340-345 cm depth was enclosed in fine gyttja.

I-3475 Riding Mountain VIII

uncorrected age: 11 140 ± 200

The calcareous lake sediment from 430-435 cm depth was enclosed in clay-gyttja overlying stoney calcareous clay beneath organic debris and gyttja.

Comment (J.C. Ritchie): In combination with the pollen record, this series of dates from same core identify the chronology of vegetation succession in this region.

I-2106 'Russell' Pond

uncorrected age: 10 250 ± 140

The gyttja was enclosed in clay and gyttja immediately below transition to a heavy clay sediment. Sample 'Ru-1' from 386-391 cm depth, was collected by J.C. Ritchie in 1966, from 'Russell' Pond, near Russell, southwestern Manitoba (50°48'N, 100°18'W). This sample was submitted by J.C. Ritchie to gain information on the pollen spectra, and climate change related to water table fluctuation.

Comment (J.C. Ritchie): The sample is from a late-glacial (*Picea - Shepherdia canadensis - Artemisia* forest community) to hypsithermal (grassland spectra) when the lake was intermittently dry.

Note: Longitude of 100° 78'W listed in Isotopes VI has been corrected.

Duck Mountain Series

A series of lake sediment samples from a 465 cm-long core in a shallow, 1.5 m depth, unnamed pond in Duck Mountain Provincial Park, Manitoba (51°39'N, 100°50'W), at an elevation of 700 m, was collected by J.C. Ritchie on June 4, 1971. These samples were submitted by J.C. Ritchie to gain information on the pollen spectra.

GSC-1629 Duck Mountain I

uncorrected age: 1960 ± 130

The organic mud, sample 'K3-B', from 185-202 cm depth was enclosed in lake mud.

Pollen zone III is dominated by *Picea* (12-20%), *Pinus* (6-10%), *Betula* (40%) and *Alnus* (20%).

GSC-1625 Duck Mountain II

uncorrected age: 4140 ± 140

The organic mud, sample 'K3-D', from 322-338 cm depth was enclosed in lake mud.

Pollen zone II is *Betula* (70%), and 20-30% nonarboreal pollen types.

GSC-1611 Duck Mountain III

uncorrected age: 5310 ± 130

The organic mud, sample 'K3-F', from 455-470 cm depth was enclosed in lake mud.

Comment (J.C. Ritchie): The pollen stratigraphy suggests that this section is truncated, and that roughly 6000 years of sedimentation is absent (Ritchie, 1976). The status of this sample remains uncertain until further sampling has been done. Pollen zone I was dominated by nonarboreal pollen with the exception of one sample (at 460 cm) which had 28% *Picea*.

The Pas moraine Series

A series of lake sediment samples from a shallow lake on The Pas moraine, 40 km west-southwest of Grand Rapids, Manitoba (53°02'N, 99°43'W) was collected by J.C. Ritchie in 1970. These samples were submitted by J.C. Ritchie to gain information on the pollen spectra.

I-6267 The Pas moraine I

uncorrected age: 3265 ± 110

The gyttja from 60-70 cm depth was enclosed in gyttja with slight silt content. This is pollen zone GR3.

I-6265 The Pas moraine II

uncorrected age: 4035 ± 95

The gyttja from 60-70 cm depth was enclosed in gyttja with slight silt content. This is pollen zone 2GR2.

I-6264 The Pas moraine III

uncorrected age: 6150 ± 110

The gyttja from 130-140 cm depth was enclosed in gyttja with slight silt content. This is pollen zone 2GR1.

I-6033 The Pas moraine IV

uncorrected age: 6345 ± 115

The gyttja from 140-150 cm depth was enclosed in gyttja with slight silt content. This is pollen zone GR1.

Comment (J.C. Ritchie): These dates were used to establish chronology of the pollen zones.

Flin Flon Series

A series of lake sediment samples from Flin Flon, Manitoba (54°44'N, 101°40'W), at an elevation of about 330 m, was collected by R.J. Mott on July 1, 1972. These samples were submitted by R.J. Mott to gain information on the pollen zones.

GSC-2638 Flin Flon I

normalized age: 2970 ± 120
$\delta^{13}C$= -31.7‰
uncorrected age: 3080 ± 120

This organic mud, sample 'F1', was from 142.5-162.5 cm depth.

GSC-2665 Flin Flon II

normalized age: 5860 ± 140
$\delta^{13}C$= -30.8‰
uncorrected age: 5950 ± 140

This organic mud, sample 'F2', was from 322.5-342.5 cm depth.

GSC-2689 Flin Flon III

normalized age: 7380 ± 130
$\delta^{13}C$= -32.0‰
uncorrected age: 7490 ± 130

This organic mud, sample 'F3', was from 382.5-402.5 cm depth.

Comment (J.C. Ritchie): A detailed percentage pollen analysis (Ritchie, 1976, 1980; Ritchie and Yarranton, 1978a, b) yielded four distinct pollen zones. The lowest is one of the few herb pollen zones recorded in the boreal forest of central Canada. The modern boreal forest became established at the site about 7000 radiocarbon years ago.

GSC-3074 Mountain Rapids

normalized age: >32 000

The wood and organic detritus (*Salix*; identified by R.J. Mott (unpublished GSC Wood Report No. 80-16)) was enclosed in sand. Sample 'DU-79-35' was collected by L.A. Dredge on July 28, 1979, from Mountain Rapids on the Churchill River, Manitoba (57°19'N, 95°47'W), at an elevation of 170.0 m. This sample was submitted by L.A. Dredge to gain information on the interglacial, and climate change as indicated by the pollen.

Comment (L.A. Dredge): The wood and pollen assemblage, dominated by Picea, Pinus, and Betula, suggests that the organics developed under environmental conditions similar to those at present, and that the deposit may be interglacial in age (unpublished GSC Palynological Report No. 81-5 by R.J. Mott). If the organics are contemporaneous with the enclosing material, then the section spans a long time interval, and records multiple glacial events. The peaty fragments, however, have rounded, abraded edges, which suggests that they may have been transported from a deposit that is stratigraphically below the enclosing sand. The interpretation of this section is discussed more fully in Dredge and Nielsen, 1985.

GSC-3988 Fletcher Lake

normalized age: 3430 ± 60
$\delta^{13}C$= -27.1‰
uncorrected age: 3460 ± 60

The peat was composed of *Sphagnum* plus Ericales and *Picea* (identified by G.M. MacDonald). Sample 'CFL-A-322-320' from the base at 324 cm depth, was collected by R. Bellows and A. Silis in June, 1984, from the western shore of Fletcher Lake, Manitoba (58°09'45"N, 93°50'15"W), at an elevation of 162 m. This sample was submitted by G.M. MacDonald to gain information on the pollen profile.

Comment (G.M. MacDonald): Dating was carried out to determine if the section would contain a complete postglacial record of vegetation development at the site. The 3430 BP date suggests that further analysis is unwarranted.

RADIOCARBON DATES RELATED TO FLUVIAL ACTIVITY (Figs. 6a and 6b)

Radiocarbon Dates from the Assiniboine River

St. Alphonse Series

A series of peat samples from about 5 km northwest of St. Alphonse along Cypress River, in the Cypress River valley, Manitoba (49°30'N, 99°04'W) was collected by J.A. Elson in 1951. These samples were submitted by J.A. Elson to gain information on alluviation in the Cypress Valley.

Y-13 St. Alphonse I

normalized age: modern

The peat sample was enclosed in alluvial fill.

Y-65 St. Alphonse II

normalized age: modern

The peat sample was enclosed in alluvial fill.

Y-64 St. Alphonse III

uncorrected age: 2560 ± 200

The charcoal sample was enclosed in alluvial fill.

Y-11 St. Alphonse IV

uncorrected age: 2830 ± 130

The wood sample was enclosed in alluvial fill.

Comment (J.A. Elson): The dated wood was from Cypress River alluvial fill that was graded to a delta of Lake Agassiz. The dates Y-13, -64, -65 were repeatedly measured by the solid-carbon method and are rejected as possibly or probably contaminated.

BGS-1821 Glenboro

uncorrected age: 6400 ± 90

The wood was enclosed in silt. Sample 'ASSR95-07' from 20 m depth, was collected by E. Nielsen, G. Matile and L.H. Thorleifson on June 27, 1995, from a river-bank section along the Assiniboine River, 6 km north of Glenboro, Manitoba (49°37'03"N, 99°19' 00"W). This sample was submitted by E. Nielsen to gain information on alluviation, and the Moorhead valley-fill.

Comment (E. Nielsen): A 22 m high section with large pieces of wood, up to 10 cm in diameter, was composed of 20 m of sand and silt over 1 m of fossiliferous silt with peat and abundant wood fragments (Moorhead fill) over stoney calcareous till.

BGS-1823 Treesbank

uncorrected age: 2910 ± 80

The bone was enclosed in highly calcareous silt. Sample 'ASSR95-03' from 30 cm depth, was collected by E. Nielsen, G. Matile and L.H. Thorleifson on June 26, 1995, from a river-bank section along the Assiniboine River, 5 km east-northeast of Treesbank, Manitoba (49°39'30"N, 99°32'38"W), at an elevation of about 345 m. This sample was submitted by E. Nielsen to gain information on fluvial processes.

Comment (E. Nielsen): A 10 m high section composed of silt over sand, then pebbly sand of point bar sequence to 3 m depth, over sand with a pebble horizon and till at 4 m depth was present at the site. The poorly defined terrace was believed to be associated with the maximum transgression of Lake Agassiz during the Emerson phase and therefore should be about 10 000 years old. The much younger date of 2.9 ka indicates the point bar is related to the modern Assiniboine River and is not graded to the maximum Lake Agassiz shoreline.

Steels Ferry Series

A series of wood samples from Assiniboine River, 3 km west of Steels Ferry, Manitoba (49°40'50"N, 99°15'55"W) was collected by E. Nielsen, G. Matile and L.H. Thorleifson on June 27, 1995. These samples were submitted by E. Nielsen to gain information on alluviation, and the Moorhead valley-fill.

BGS-1817 Steels Ferry I

uncorrected age: 2500 ± 70

The wood sample (ASSR95-08-A) was enclosed in near-surface eolian sand (surface dunes).

The calibrated age is 2590 ± 70.

BGS-1816 Steels Ferry II

uncorrected age: 2600 ± 70

The wood sample (ASSR95-08-B) was enclosed in calcareous silt underlying 22 m of Assiniboine Delta and eolian sand.

The calibrated age is 2750 ± 70.

Comment (E. Nielsen): A 25 m high section composed of 22 m of Assiniboine Delta and eolian sand over 3 m of fossiliferous silt with peat and abundant wood fragments (Moorhead valley fill) was present at the site. David (1971) dated bulk organic material from paleosols in the Brandon area with ages of 400 to 3700 rcybp. This sample is in a similar context and the age is compatible with his dates.

S-94 Holland

uncorrected age: 3200 ± 75

The wood was enclosed in sand and gravel overlying till and underlying about 46 m of disturbed clay and silt. The sample was collected by D.H. Pollock in June, 1959, from a deep gully leading into Assiniboine River valley, north of Holland, Manitoba (49°42'N, 98°50'W), at an elevation of 293 m. This sample was submitted by G.L. MacKenzie to gain information on fluvial processes, and a landslide(?).

Comment (G.L. MacKenzie): The age does not correspond to inundation of the area by Glacial Lake Agassiz, as was first suspected. Rather the age indicates when slumping of lacustrine sediments into the gully buried organic debris in the creek bed and displaced the creek from its course.

GX-3696 Glenboro

uncorrected age: 9880 ± 225

The wood (*Picea*) was enclosed in sand and gravel and overlies laminated clayey silt to silty clay. The sample was collected by J.T. Teller in 1974, from about 16 km north of Glenboro, 1 km east of highway 258 in the northwest bank of Assiniboine River, Manitoba (49°42'N, 99°15'W), at an elevation of 327.7 m. This sample was submitted by J.T. Teller to gain information on fluvial processes, and the regional baselevel rise.

Comment (J.T. Teller): Sand and gravel was deposited during the last rise of Lake Agassiz in southern Manitoba which caused regional baselevel to rise and, in turn, the gradient of Old Assiniboine River to decline.

BGS-1822 Carie Flats

uncorrected age: 2330 ± 70

The wood was enclosed in organic silt with wood fragments (Moorhead fill). Sample 'ASSR95-10' from 4 m depth, was collected by E. Nielsen, G. Matile and L.H. Thorleifson on June 27, 1995, from a river-bank section along the Assiniboine River, near Carie Flats, Manitoba (49°43'24"N, 98°57'25"W). This sample was submitted by E. Nielsen to gain information on alluviation, and the Moorhead valley-fill.

Comment (E. Nielsen): A 5 m-high section was composed of 3 m of slumped material over a 2 m organic silt with wood fragments (Moorhead fill) overlying a silt unit with silt clasts, over till.

BGS-1436 Red River junction

uncorrected age: 575 ± 70

The bison bone was enclosed in highly calcareous alluvial silt. Sample 'BP 5(a)' from 1.4-1.6 m depth, was collected by E. Nielsen on May 31, 1990, from Assiniboine River, 26 km west of junction with Red River, Manitoba (49°50'30"N, 97°30'00"W). This sample was submitted by E. Nielsen to gain information on fluvial processes, rate of sedimentation, and occupation of modern channel.

Comment (E. Nielsen): Bison bones were from a well drained silt in a recent natural river exposure with no obvious plant growth. The sample helps determine sedimentation rate along Assiniboine River and date occupation of the modern river in this valley.

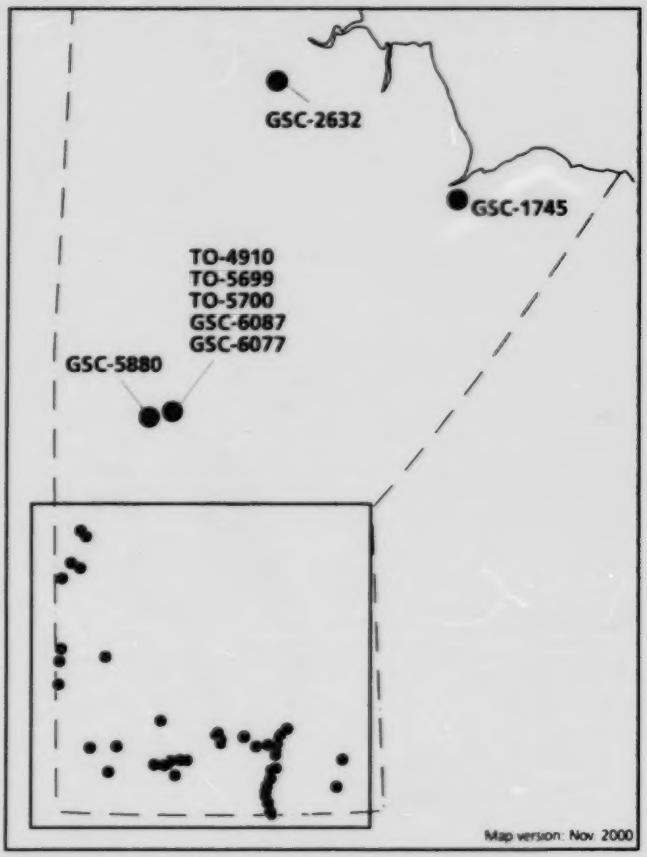

Figure 6a. Radiocarbon dates related to fluvial activity. See Fig. 6b for dates in area marked by rectangle.

BGS-1410 Truro Creek

uncorrected age: 325 ± 100

The bison bone was enclosed in calcareous alluvial silt. Sample 'IN 86-1' from about 2 m depth was collected by E. Nielsen on July 16, 1986, from a terrace on the south side of Assiniboine River and Truro Creek in Bruce Park at the west end of Winnipeg, Manitoba (49°52'32"N, 97°13'32"W), at an elevation of 232.5 m. This sample was submitted by E. Nielsen to gain information on fluvial processes, and the timing of the occupation of the Assinibione River.

Comment (E. Nielsen): The sample was from a natural river cut where Truro Creek joins Assiniboine River in the west end of Winnipeg. The sample was excavated from dry compact silt with no mold or plant growth. The date helps establish timing of the occupation of Assiniboine River. A date of 7500 ± 80 (GSC-4839) suggests that the river occupied the present course in the early Holocene. Rannie et al. (1989) suggest that the river drained into Lake Manitoba between 7.5 and 3.0 ka BP.

GSC-4839 Winnipeg

normalized age: 7500 ± 80
$\delta^{13}C = -24.6‰$
uncorrected age: 7490 ± 80

The deciduous wood (according to H. Jetté (unpublished GSC Wood Report No. 89-26)) was enclosed in clay. Sample 'G.L.-69-1'

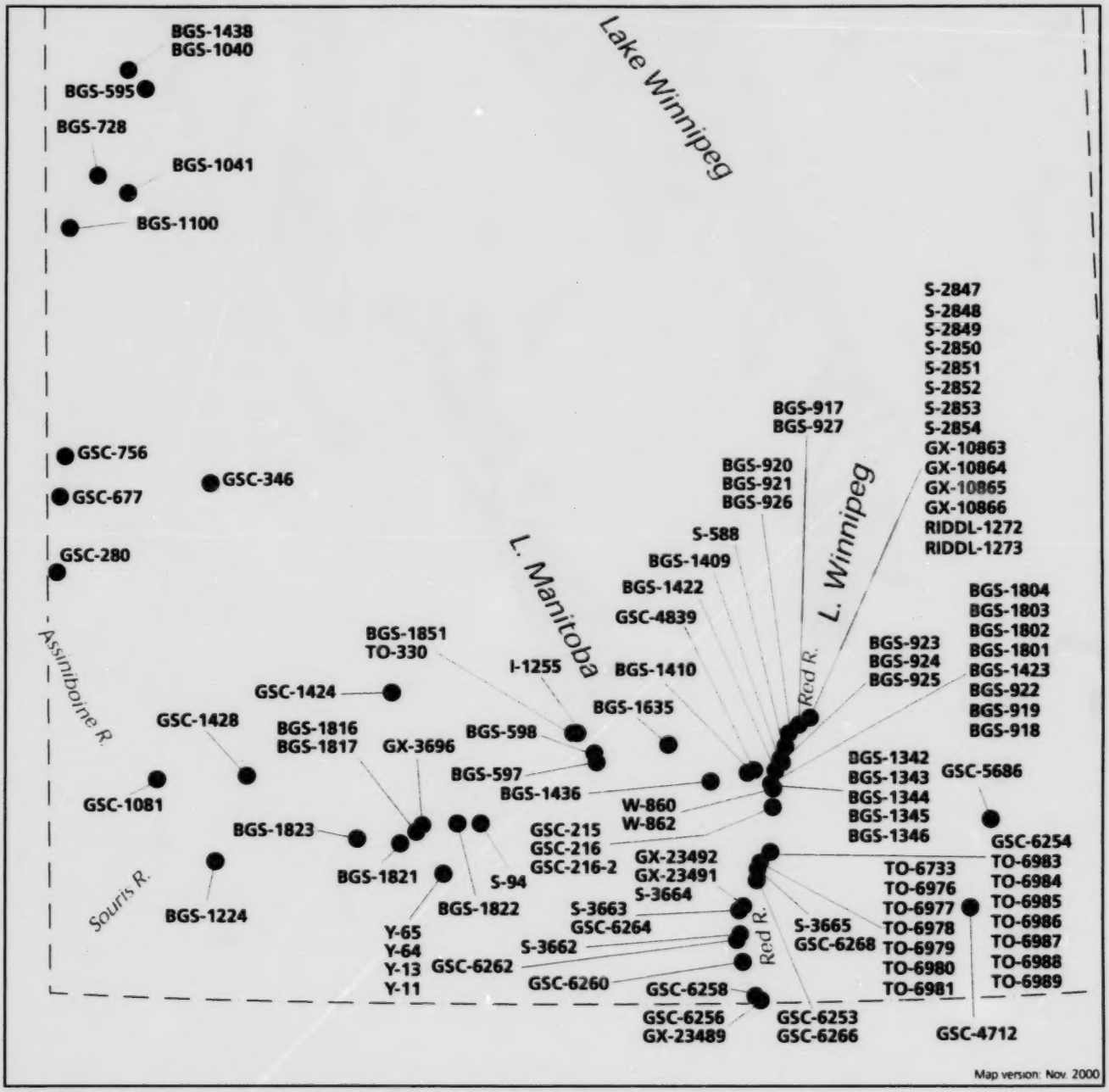

Figure 6b. Radiocarbon dates related to fluvial activity in southern Manitoba. See rectangle inset in Fig. 6a.

from 10.5 m depth was collected by G. Lammers in November, 1969, from a sewer excavation near the corner of Ruby Street and Wolseley Avenue, about 0.25 km north of the Assiniboine River in downtown Winnipeg, Manitoba (49°52'45"N, 97°10'20"W), at an elevation of 221 m. This sample was submitted by E. Nielsen to gain information on fluvial processes, and early Holocene drainage.

Comment (E. Nielsen): The wood sample, collected from a depth of 10.5 m in association with bison bones and large pelecypods (bivalve molluscs, e.g. *Unio*), was deposited as river alluvium by the Assiniboine River shortly after the drainage of Lake Agassiz.

GSC-1081 Virden

uncorrected age: 11 600 ± 430

The organic detritus was enclosed in alluvium. Sample 'TH-4-68' from 18.3 m depth (60' to 62'), was collected by R.W. Klassen on August 25, 1968 near Virden on the Assiniboine River floodplain, Manitoba (49°52.8'N, 100°49.8'W). This sample was submitted by R.W. Klassen to gain information on alluviation.

In Lowdon, et al., 1971 (p. 286) the coordinates were given as 49°53'N Lat, 100°50'W and should be corrected as above.

Comment (R.W. Klassen): The sample was 18 m below the surface of floodplain which is the deepest obtained from Assiniboine Valley fill. The sample dates an early phase of valley filling after building of Assiniboine Delta (Klassen, 1969). The date suggests that the lower zone near the bedrock contact, about 30.48 m deeper, is of mid-Wisconsinan age.

GSC-1428 Alexander

uncorrected age: 10 000 ± 280

The wood (*Picea* or *Larix*; identified by R.J. Mott) was enclosed in alluvium. Sample 'Testhole #5-70' from 9.15 m depth, was collected by R.W. Klassen on August 5, 1970, from 8 km (5 mi) north of Alexander on the Assiniboine River flats, Manitoba (49°54'N, 100°18'W), at an elevation of 354 m. This sample was submitted by R.W. Klassen to gain information on alluviation.

Comments (R.W. Klassen): The date is minimum for the age of the alluvium which is about 18 m-thick above bedrock in this late-glacial segement of Assiniboine River.

BGS-597 Portage la Prairie I

uncorrected age: 1270 ± 170

The fine-grained charcoal was enclosed in a paleosol in massive light brown silt containing up to 5 paleosol horizons. The sample was collected by S. Ringrose in 1978, from 9 km east of Portage la Prairie, on the north side of the Assiniboine River, Manitoba (49°58'N, 98°09'W). This sample was submitted by S. Ringrose to gain information on alluviation.

Stratigraphy:
0.2 m Lake Agassiz clay and silt;
1.0 m massive light brown silt containing up to 5 paleosol horizons with a few gastropods;
0.3 m cross-laminated silt.

Comment (S. Ringrose): This sample probably reflects a period of stability between alluviation events of Assiniboine River.

BGS-598 Portage la Prairie II

uncorrected age: 2580 ± 150

The finely disseminated organic material was enclosed in a paleosol in 2 m of massive fine sand and silt with numerous paleosols. The sample was collected by S. Ringrose in 1978, from 8 km east of Portage la Prairie on the south side of the Assiniboine River, Manitoba (49°59'30"N, 98°09'W). This sample was submitted by S. Ringrose to gain information on alluviation, and fan development.

Stratigraphy:
2.0 m massive fine sand and silt with numerous paleosols;
1.5 m bedded clay and organic-bearing silt with gastropods.

Comments (S. Ringrose): The sample probably dates the sequence deposited when the Assiniboine River was constructing an alluvial fan in Portage la Prairie area.

BGS-1635 Marquette

uncorrected age: 2450 ± 80

The paleosol (organic soil) was enclosed in calcareous silt of Lake Agassiz varved clay. Sample 'Assin 92-7' from 1 m depth, was collected by E. Nielsen on May 13, 1992, along the north shore of the Assiniboine River, 5.5 km south of Marquette, southern Manitoba (50°00'50"N, 97°45'10"W), at an elevation of 243 m. This sample was submitted by E. Nielsen to gain information on alluviation.

Comment (E. Nielsen): The date determines the initiation of overbank sedimentation along this part of the Assiniboine River.

I-1255 Delta Marsh

uncorrected age: 3375 ± 250

The basal wood was enclosed in a 6 m-thick surface sand overlying 20.7 m of clay which overlies 'red till'. The borehole sample was collected by J.A. Gilliland in 1963, in the Delta Marsh, 13.7 km south of the Lake Manitoba shore, 8.0 km north of Portage la Prairie and 5.5 km south of Oakland, Manitoba (50°03'N, 98°17'W), at an elevation of 254.6 m. This sample was submitted by J.A. Gilliland to gain information on fluvial processes, and the paleochannel.

Comment (J.A. Gilliland): Sand probably was deposited within a distributary channel of the old Assiniboine River.

BGS-1851 'Blind Channel'

uncorrected age: 4230 ± 70

The oak log (identified by E. Nielsen) was enclosed in calcareous sand and silt. Sample 'Assin 95-5' was collected by E. Nielsen on November 15, 1995, from an abandoned channel of the Assiniboine River, Blind Channel, 9.6 km (6 mi) north of Portage la Prairie, Manitoba (50°03'08"N, 98°17'45"W), at an elevation of about 253 m. This sample was submitted by E. Nielsen to gain information on alluviation, and the paleochannel.

Comment (E. Nielsen): The date confirms the existence of 'Blind Channel' at about 4.2 ka BP. Previous age estimates ranged between 3.4 ka (I-1255) and 4.5 ka (TO-330). The younger of these two dates, as indicated by the published location, was not from the 'Blind Channel'.

TO-330 'Blind Channel'

normalized age: 4520 ± 60

The unidentified freshwater shells were enclosed in calcareous sand and silt?. The sample was collected by E. Nielsen from an abandoned channel of the Assiniboine River, Blind Channel, 9.6 km (6 mi) north of Portage la Prairie, Manitoba (50°03'08"N, 98°17'45"W), at an elevation of about 253 m. This sample was submitted by E. Nielsen to gain information on the geomorphic processes, specifically alluviation of the Assiniboine River.

The age was normalized to a $\delta^{13}C = -25‰$.

Comment (E. Nielsen): The date indicates that the Blind Channel was active about 4.5 ka BP. Previous age estimate of 3.4 ka (I-1255), as indicated by the published location, was not from the Blind Channel. BGS-1851 more precisely dates the channel at 4.2 ka.

GSC-280 Russell

uncorrected age: 6320 ± 140

The wood was enclosed in organic clay alluvium. Sample 'KF-36-64' was collected by R.W. Klassen on June 4, 1964, in the diversion channel cut in Assiniboine River floodplain, 10 km west of Russell, Manitoba (50°46'N, 101°26'W). This sample was submitted by R.W. Klassen to gain information on alluviation.

Comment (R.W. Klassen): The sample (twigs) was from the bottom of a cut in an organic clay zone containing twigs and bison bone fragments. The zone is overlain by 4 m of silty clay including beds of pelecypod-bearing silt, sand, and gravel, and is underlain by 18 m of clay, in part probably lacustrine.

The date marks a late phase of valley-filling. Nielsen et al. (1984, p. 837) suggest the associated skull is *Bison occidentalis*.

GSC-677 Shellmouth

uncorrected age: 10 690 ± 190

The wood was enclosed in alluvial silt beneath a till slump block. Sample 'KJ-17A-66' was collected by R.W. Klassen on June 8, 1966, from about 3 m above the floodplain, at a damsite excavation at the base of the east wall in the Assiniboine River valley, 6 km northeast of Shellmouth, Manitoba (50°58'N, 101°24'W). This sample was submitted by R.W. Klassen to gain information on alluviation, and provide a minimum age for the initiation of the Assiniboine.

Comment (R.W. Klassen): The date GSC-677 is minimum for the development of the Assiniboine River valley. See GSC-678 (p. 126) in the section on 'Pre-Holocene' dates for additional information.

GSC-756 Roblin

uncorrected age: 2760 ± 130

The wood was enclosed in alluvium. Sample 'KJ-46-66' was collected by R.W. Klassen on August 3, 1966, from 9.6 km southwest of Roblin on the Assiniboine River floodplain, Manitoba (51°07'N, 101°26'W). This sample was submitted by R.W. Klassen to gain information on alluviation.

Comment (R.W. Klassen): The sample was believed to be from 12 to 15 m depth in river alluvium, but the young date indicates that it was from a near-surface source.

Radiocarbon Dates along the Red River

Emerson Series

A series of samples from a section along the Red River, 5 km north of Emerson, Manitoba (49°03'10"N, 97°11'45"W), at an elevation of 234 m, was collected by E. Nielsen and G. Matile on October 1, 1997. These samples were submitted by E. Nielsen to gain information on the flood history of the Red River.

GX-23489 Emerson I

normalized age: 3490 ± 135

The charcoal(?) sample 'RR-97-10' from 4.4 m depth was enclosed in brown clay.

GSC-6256 Emerson II

normalized age: 2170 ± 70
$\delta^{13}C$= -22.79‰
uncorrected age: 2140 ± 70

The charcoal sample 'RR-97-09' from 2.1 m depth was enclosed in brown clay.

GSC-6258 Emerson III

normalized age: 100 ± 60
$\delta^{13}C$= -28.07‰
uncorrected age: 150 ± 60

The charcoal (*Fraxinus* probably; identified by C. Keith) was enclosed in silty calcareous sand alluvium. Sample 'RR-97-11' from 1.1 m depth was collected by E. Nielsen and G. Matile on October 1, 1997, from 6.5 km north of Emerson, about 90 km south of Winnipeg in the Red River valley, Manitoba (49°04'20"N, 97°13'10"W), at an elevation of 225 m. This sample was submitted by E. Nielsen to gain information on the flood history of the Red River.

Comment (E. Nielsen): The sample was collected 1.1 m down in a fresh 3 m high exposure at the top of a terrace (floodplain) of the Red River about 8 m high. Young ash trees on the top of the section suggest that these sediments are young.

GSC-6260 Letellier

normalized age: 2460 ± 70
$\delta^{13}C$= -24.50‰
uncorrected age: 2450 ± 70

The charcoal (*Fraxinus* probably; identified by C. Keith) was enclosed in silty clay and clay. Sample 'RR-97-12' from 1.60 m depth was collected by E. Nielsen and G. Matile on October 1, 1997, from 9 km north of Letellier, in the Red River valley, Manitoba (49°11'50"N, 97°18'20"W), at an elevation of 234 m. This sample was submitted by E. Nielsen to gain information on the flood history.

GSC-6262 Morris

normalized age: 310 ± 50
$\delta^{13}C$= -27.72‰
uncorrected age: 360 ± 50

The wood (unidentifiable according to C. Keith) was enclosed in laminated clay alluvium. Sample 'RR-97-13' from 3.8 m depth was collected by E. Nielsen and G. Matile on October 1, 1997, from about 9 km south of Morris, about 70 km south of Winnipeg in the Red River valley, Manitoba (49°16'30"N, 97°19'40"W), at an elevation of about 228 m. This sample was submitted by E. Nielsen to gain information on the fluvial terrace, and flood history.

Comment (E. Nielsen): A stump was removed from a clean, fresh section at a depth of 3.8 m in a 5.3 m high terrace. The upper 1.6 m was vertical and lower 3.7 m sloped slightly towards the river. Good soil development at the top of the section suggests that this site is old and sedimentation has ceased on the upper surface.

S-3662 Morris

normalized age: 5380 ± 90
$\delta^{13}C$= -18.72‰
uncorrected age: 5280 ± 90

The bone, the left tibia of a bison (identified by R.E. Morlan), was enclosed in calcareous silty clay in horizontally stratified alluvium. Sample 'RR-97-14' from 4.8 m depth was collected by E. Nielsen and G. Matile on October 2, 1997, from 7 km south of Morris, about 68 km south of Winnipeg in the Red River valley, Manitoba (49°17'35"N, 97°19'10"W), at an elevation of about 228 m. This sample was submitted by E. Nielsen to gain information on the fluvial terrace, and flood history.

Comments (R.E. Morlan): The sample was a left tibia of a bison with the proximal end missing, and measurements of the distal end (breadth = 7.8 cm; depth = 6.0 cm) show that this bison was almost certainly an adult male. These measurements are near the upper end of the size range for modern Plains bison bulls, and it is possible that an older chrono-subspecies such as *B. bison occidentalis* is represented. The manner of removal of the proximal end of this bone is consistent with damage caused by large carnivorous mammals. However, no definite tooth-marks are preserved. The bone lay on the surface for a brief period (a few months?) prior to burial as shown by longitudinal cracking similar to Behrensmeyer's (1978) stage 1 weathering. While in the active layer, the bone was etched by plant roots, but the degree of etching is quite modest and the extent of etching is scattered and localized. Interruption of the etching process suggests a relatively short interval of time before deeper burial was achieved. There is no evidence of human intervention in the dismemberment or defleshing of this bison.

Morris A Series

A series of samples from about 3 km northeast of Morris, about 55 km south of Winnipeg in the Red River valley, Manitoba (49°22'45"N, 97°19'15"W), at an elevation of about 228 m, was collected by E. Nielsen and G. Matile on October 3, 1997. These samples were submitted by E. Nielsen to gain information on the fluvial terrace, and flood history.

GSC-6264 Morris I

normalized age: 80 ± 60
$\delta^{13}C$= -28.91‰
uncorrected age: 140 ± 60

The wood (*Populus*; identified by C. Keith), sample 'RR-97-16' from 2.0 m depth, was enclosed in silt and silty clay alluvium. The sample was collected from the modern flood plain where the total height of the section was 3 m.

S-3663 Morris II

normalized age: 350 ± 70
$\delta^{13}C$= -15.67‰
uncorrected: 200 ± 70

The bone, left tibia of a Bison (identified by R.E. Morlan), sample 'RR-97-17' from 2.3 m depth was enclosed in silt and silty clay alluvium of a fresh exposure 0.3 m below GSC-6264 (RR-97-16) in the modern floodplain.

Comments (R.E. Morlan): This sample was a bison left tibia, wholly intact, with proximal and distal ends completely fused. The measurements of the distal end (breadth = 7.2 cm; depth = 5.1 cm) suggest that this bison was probably a relatively small adult bull. These measurements are near the lower end of the size range for modern Plains bison bulls and are smaller than the largest adult female bison tibia in Morlan's comparative data. There is no evidence bearing upon the cause of death of this bison. The bone lay on the surface for a brief period (a few months?) prior to burial and is weathered to Behrensmeyer's stage 1. During this period on the surface, a rodent gnawed on a small area of the anterior crest. The bone may have entered into a relatively deep burial environment rather quickly, because there is no evidence of root-etching.

Morris B Series

A series of samples from about 4 km northeast of Morris, about 58 km south of Winnipeg in the Red River valley, Manitoba (49°23'25"N, 97°18'20"W), at an elevation of about 228 m, was collected by E. Nielsen and G. Matile on October 3, 1997. These samples were submitted by E. Nielsen to gain information on the fluvial terrace, and flood history.

GX-23491 Morris I

normalized age: modern

The wood sample 'RR-97-19' from 3.2 m depth was enclosed in olive-coloured, laminated alluvium in a fresh exposure in Red River floodplain.

GX-23492 Morris II

normalized age: modern

The charcoal sample 'RR-97-20' from 4.6 m depth was enclosed in massive yellow silt underlying about 3.5 m of olive-coloured, laminated alluvium in a fresh exposure in Red River floodplain.

S-3664 Morris III

normalized age: 1840 ± 80
$\delta^{13}C$= -14.95‰
uncorrected age: 1680 ± 80

The bone fragments (*Bison*; identified by R.E. Morlan), sample 'RR-97-18' from 4.6 m depth, were enclosed in massive yellow silt underlying about 3.5 m of olive-coloured, laminated alluvium in a fresh exposure in Red River floodplain. Charcoal from the same level (4.6 m) dated modern (GX-23492) and wood from 3.2 m also dated modern (GX-23491).

Comments (R.E. Morlan): This sample of bison bone fragments included part of a left temporal bone; three fragments from the upper part of the brain case; both left and right nasal bones; a thoracic vertebra centrum with the complete neural arch and the base of the neural spine; and segments of two ribs, one of which has the proximal end intact. Evidence of subaerial weathering and

root etching is minimal, and there is no sign of gnawing by carnivores or rodents, no sign of butchering by people. The bones were probably deeply buried soon after the death of the animal(s).

Aubigny Series

A series of samples from about 4 km north of Aubigny, about 45 km south of Winnipeg in the Red River valley, Manitoba (49°29'40"N, 97°13'45"W), at an elevation of about 228 m, was collected by E. Nielsen and G. Matile on October 3, 1997. These samples were submitted by E. Nielsen to gain information on the fluvial terrace, and flood history.

GSC-6266 Aubigny I

normalized age: 4050 ± 80
$\delta^{13}C$= -26.44‰
uncorrected age: 4080 ± 80

The rounded fragments of wood charcoal (probably *Fraxinus*; identified by C. Keith), sample 'RR-97-21(a)' from 4.4 m depth were enclosed in silty, calcareous clay. When compared with 'RR-97-21(b)' (GSC-6253), this date will provide the 'hardwater' correction for the Red River and Lake Winnipeg. This sample was submitted by E. Nielsen as a crosscheck date.

GSC-6253 Aubigny II

normalized age: 4320 ± 70
$\delta^{13}C$= -8.16‰
uncorrected age: 4040 ± 70

The freshwater shells, whole valves of *Sphaerium simile?/ striatinum?*; (identified by J-M. Gagnon), sample 'RR-97-21(b)' from 4.4 m depth were enclosed in silty, calcareous clay. When compared with 'RR-97-21(a)' (GSC-6266), this date will provide the 'hardwater' correction for the Red River and Lake Winnipeg.

Comments (E. Nielsen): The 'hardwater' error in this area is about 270 years as defined by GSC-6266 and -6253.

GSC-6268 Ste. Agathe

normalized age: 2190 ± 50
$\delta^{13}C$= -23.29‰
uncorrected age: 2160 ± 50

The wood charcoal (probably *Fraxinus*; identified by C. Keith) was enclosed in clay and silty clay alluvium. Sample 'RR-97-26' from about 4.5 m depth was collected by E. Nielsen and G. Matile on December 3, 1997, from about 5 km south of Ste. Agathe, about 40 km south of Winnipeg in the Red River valley, Manitoba (49°31'40"N, 97°13'05"W), at an elevation of about 223 m. This sample was submitted by E. Nielsen to gain information on the fluvial terrace, and flood history.

S-3665 Ste. Agathe

normalized age: 2770 ± 80
$\delta^{13}C$= -17.44‰
uncorrected: 2650 ± 80

The *Bison* bone fragments (identified by R.E. Morlan) were enclosed in silt and silty clay alluvium. Sample 'RR-97-25' from 80 cm depth was collected by E. Nielsen and G. Matile on November 7, 1997, from about 5 km south of Ste. Agathe, about 40 km south of Winnipeg in the Red River valley, Manitoba (49°31'40"N, 97°13'05"W), at an elevation of about 228 m. This sample was submitted by E. Nielsen to gain information on the fluvial terrace and flood history, and possibly geoarchaeology.

Comments (R.E. Morlan): This sample of bison bone fragments included portions of a right ankle assembly of a bull (distal tibia, lateral malleolus, talus, calcaneus, tarsal C+4); distal metatarsal; humerus shaft; and miscellaneous long bone and rib fragments. Some of these are not identifiable, but their association with the definite bison bones renders it likely that they represent the same species, perhaps the same individual animal. The bones exhibit almost no evidence of subaerial weathering and only very minor root etching. There is no evidence of gnawing by rodents or carnivores. Some of the very robust long bone fragments appear to have been fractured when fresh, and they could reflect human butchery practices such as marrow retrieval. However, the evidence has been obscured by much recently inflicted damage caused by vigorous excavation methods. The $\delta^{13}C$ measurements on these four samples of bison bones (S-3362, -3663, -3664, and -3665) from Manitoba, all reflect significant amounts of C-4 plants in the bison's diet. The ratios for S-3663 and -3664 show that as much as 50% of the bison's diet consisted of C-4 plants in the late Holocene.

St. Agathe A Series

All seven dates of the 'St. Agathe A Series' were obtained on organic samples contained in a natural cutbank of the Red River, 3 km south-southwest of the intersection of highways 75 and 305 at the town of St. Agathe, southern Manitoba (49°32.6'N, 97°12.1'W). The cutbank was formed by lateral bank erosion into alluvial deposits that have aggraded within a shallow valley incised into the Glacial Lake Agassiz plain along the Red River Valley. The elevation of the top of the bank is 234 ± 1 m. The samples were collected by G.R. Brooks on September 4 and 5, and by G.R. Brooks and G. Matile on June 7, 1997. These samples were submitted by G.R. Brooks to investigate the alluvial history of the Red River valley.

TO-6978 St. Agathe I

normalized age: modern

The charcoal sample '97-09-04-C14-14' from 6.70 m depth was enclosed in clay-silt alluvium.

The age was normalized to a $\delta^{13}C$ of -25‰.

The sample consisted of a single fragment from a piece of charcoal that appeared to be well preserved. Concentrations of calcite precipitate (irregular shape, several centimeters in diameter, white, authigenic, fracture-filling, fine-grained) were present in this part of the bank. The sample formed part of a short line of small charcoal fragments (less than 10 mm in size).

TO-6980 St. Agathe II

normalized age: 2910 ± 90

The charcoal sample '97-09-05-C14-26' from 1.45 m depth was enclosed in silt-clay alluvium.

The age was normalized to a $\delta^{13}C$ of -25‰.

The sample consists of two fragments from a single piece of charcoal. The sample was part of a lamination consisting of humic

organic matter and charcoal. The sample seems to be well preserved. Numerous modern roots were present in this area of the bank.

TO-6981 St. Agathe III

normalized age: 3870 ± 110

The charcoal sample '97-09-05-C14-28' from 8.80 m depth was enclosed in silt-clay alluvium.

The age was normalized to a $\delta^{13}C$ of -25‰.

The sample consisted of several fragments from a single piece of charcoal. The sample seemed to be well preserved. Concentrations of calcite precipitate (irregular shape, several centimeters in diameter, white, authigenic, fracture-filling, fine-grained) were present in this part of the bank.

TO-6976 St. Agathe IV

normalized age: 4040 ± 110

The charcoal sample '97-09-04-C14-04' from 2.80 m depth was enclosed in clay-silt alluvium.

The age was normalized to a $\delta^{13}C$ of -25‰.

The sample consisted of a number of fragments of a single piece of charcoal. The sample seemed to be well preserved. Modern roots were present in the general area of the sample and within unsubmitted pieces in the sample. Concentrations of calcite precipitate (irregular shape, several centimeters in diameter, white, authigenic, fracture-filling, fine-grained) were present in this part of the bank.

TO-6979 St. Agathe V

normalized age: 4400 ± 80

The charcoal sample '97-09-04-C14-25' from 4.60 m depth was enclosed in clay-silt alluvium.

The age was normalized to a $\delta^{13}C$ of -25‰.

The sample consisted of two fragments from a single piece of charcoal. The sample seemed to be well preserved. The occasional modern root was present in the area of the sample. Concentrations of calcite precipitate (irregular shape, several centimeters in diameter, white, authigenic, fracture-filling, fine-grained) were present in this part of the bank.

TO-6733 St. Agathe VI

normalized age: 5430 ± 70

The teeth of a *Bison* (identified by R.E. Morlan), sample '97-Jun07-StA-C01' from 6.1 m depth, were enclosed in clay-silt alluvium.

The age was normalized to a $\delta^{13}C$ of -25‰.

The dated sample was one of three teeth which were part of a collection of broken pieces of bones. Most of the bones are poorly to moderately preserved and seem to have been weathered prior to deposition. The teeth, however, are well preserved (intact, enamel still present).

(Cal Age) ± 1 sigma:
6180 (6275) 6295
6180 (6235) 6295
6180 (6210) 6295

TO-6977 St. Agathe VII

normalized age 5430 ± 70

The charcoal sample '97-09-04-C14-13' from 6.70 m depth was enclosed in clay-silt alluvium.

The age was normalized to a $\delta^{13}C$ of -25‰.

The sample consists of a single fragment from a larger piece of charcoal. The sample seemed to be well preserved. Concentrations of calcite precipitate (irregular shape, several centimeters in diameter, white, authigenic, fracture-filling, fine-grained) were present in this part of the bank.

Comment (G.R. Brooks): Little was known, at the time of sample submission, about the chronology of alluvial deposits of the Red River. The seven samples were obtained from different depths within a measured section of a cutbank exposure. Collectively, the dates based on these samples provide chronologic information on the aggradation of alluvial deposits and provide insights into the Holocene history of the Red River. The oldest dates indicate that alluvial sedimentation at this site began prior to 5.4 ka BP and that the bank deposits below 1.45 m predate 2.9 ka BP.

However, two of the dates (TO-6978 and -6981) are significantly younger than their stratigraphic position would suggest relative to the other dates. These two dates resulted from younger material that was inadvertently sampled and are therefore interpreted to be unrepresentative of the age of the enclosing deposits at their respective sampling depths.

The samples, collected in a natural cutbank of the Red River, were from the following depths:

97-09-05-C14-26	1.45m	2910 ± 90	TO-6980
97-09-04-C14-04	2.80m	4040 ± 110	TO-6976
97-09-04-C14-25	4.60m	4400 ± 80	TO-6979
97-Jun07-StA-C01	6.10m	5430 ± 70	TO-6733
97-09-04-C14-13	6.70m	5430 ± 70	TO-6977
97-09-04-C14-14	6.70m	modern	TO-6978
97-09-05-C14-28	8.80m	3870 ± 110	TO-6981

Ste. Agathe B Series

A series of samples from a borrow pit along the shore of Red River, 3 km northeast of Ste. Agathe, Manitoba (49°35'05"N, 97°08'45"W), at an elevation of 234 m, was collected by E. Nielsen and G. Matile on September 30, 1997. These samples were submitted by E. Nielsen to gain information on fluvial processes, and flood history.

TO-6983 Ste. Agathe I

normalized age: 3280 ± 80

The charcoal sample 'RR-97-01' from 0.70 m depth was enclosed in silty clay and clay.

The age was normalized to a $\delta^{13}C$ of -25‰.

TO-6984 Ste. Agathe II

normalized age: 4360 ± 100

The charcoal sample 'RR-97-02' from 1.05 m depth was enclosed in silty clay and clay.

The age was normalized to a $\delta^{13}C$ of -25‰.

TO-6985 Ste. Agathe III

normalized age: 4640 ± 90

The charcoal sample 'RR-97-03' from 1.65 m depth was enclosed in silty clay and clay.

The age was normalized to a $\delta^{13}C$ of -25‰.

TO-6987 Ste. Agathe IV

normalized age: 4850 ± 70

The charcoal sample 'RR-97-05' from 2.00 m depth was enclosed in silty clay and clay.

The age was normalized to a $\delta^{13}C$ of -25‰.

TO-6986 Ste. Agathe V

normalized age: 4860 ± 70

The charcoal sample 'RR-97-04' from 1.85 m depth was enclosed in silty clay and clay.

The age was normalized to a $\delta^{13}C$ of -25‰.

TO-6989 Ste. Agathe VI

normalized age: 5590 ± 70

The charcoal sample 'RR-97-08' from 3.50 m depth was enclosed in silty clay and clay.

The age was normalized to a $\delta^{13}C$ of -25‰.

TO-6988 Ste. Agathe VII

normalized age; 5900 ± 70

The charcoal sample 'RR-97-07' from 3.20 m depth was enclosed in silty clay and clay.

The age was normalized to a $\delta^{13}C$ of -25‰.

GSC-6254 Ste. Agathe VIII

normalized age: 5570 ± 80
$\delta^{13}C$= -24.88‰
uncorrected age: 5570 ± 80

The charcoal sample 'RR-97-06' from 3.00 m depth was enclosed in silty clay and clay.

Laboratory Comment: Because some rootlets may have been present in the samples from shallow depths, all samples were inspected under binocular microscope (6x) and all modern rootlets were removed by M. Pyne. Only cohesive chunks of charcoal were submitted for dating.

The samples that were collected from the upper Red River terrace were from the following depths:

RR-97-01	0.70m	TO-6983	3280 ± 80
RR-97-02	1.05m	TO-6984	4360 ± 100
RR-97-03	1.65m	TO-6985	4640 ± 90
RR-97-04	1.85m	TO-6986	4860 ± 70
RR-97-05	2.00m	TO-6987	4850 ± 70
RR-97-06	3.00m	GSC-6254	5570 ± 80
RR-97-07	3.20m	TO-6988	5900 ± 70
RR-97-08	3.50m	TO-6989	5590 ± 70

St. Vital Series

A series of samples 43 m from the river's edge and at the bottom of the Winnipeg Floodway diversion channel, on the bank of the Red River in lot 174 of St. Vital, Winnipeg, Manitoba (49°45'N, 97°08'W), at an elevation of 223 m, was collected by R.W. Klassen on September 20, 1963. These samples were submitted by R.W. Klassen to gain information on the fluvial processes, and alluviation of the Floodway, as well as a crosscheck date.

GSC-215 St. Vital I

uncorrected age: 3650 ± 140

The freshwater shell *(Lasmigona costata*; revised by J-M. Gagnon), sample 'KJ-3A-63' from 7.6 m depth enclosed in alluvial silt.

GSC-216 St. Vital II

uncorrected age: 3660 ± 130

The wood sample 'KJ-1A-63' from 7.6 m depth was enclosed in alluvial silt. This date was on 'mold-free' wood; analysis of a 'moldy' piece of the same wood yielded an age of 3610 ± 130.

Comment (R.W. Klassen): The dates of this series fall within an episode of aggradation by the Red River that began about 6.8 ka BP.

GSC-216 2 St. Vital III

uncorrected age: 3610 ± 130

The 'moldy wood' sample (KJ-1A-63) was a root of a tilted tree, in alluvial clayey silt overlain by similar inorganic silt. Two measurements were made of this sample (mold-free wood, GSC-216; moldy wood, GSC-216 2).

Comment (R.W. Klassen): The pair of dates for moldy and mold-free wood shows that moldy wood can yield a reliable date.

General comment on series (R.W. Klassen): The dates fall within an episode of aggradation by Red River that began about 6750 years ago (Elson, 1962). Close agreement between dates for shell and wood indicates that dates for freshwater shells can be reliable.

Fort Garry Series

A series of samples from the west side of the Red River near the Bishop Grandin Boulevard bridge, in a vertical shaft for Winnipeg Water District aqueduct about 770 m N55°E of Pembina Highway and University Crescent, Fort Garry, Winnipeg, Manitoba (49°49'20"N, 97°08'47"W) was collected by W. Cornick and E. Leith in 1959. These samples were submitted by E. Leith to gain information on fluvial processes, alluviation, and early Holocene drainage.

W-860 Fort Garry I

uncorrected age: 6200 ± 320

The *Populus balsamifera* wood (identified by the Forest Product Laboratory) from 14 m depth was enclosed in clayey silt that underlies 1.5 m of silty clay and overlies 7.6 m of laminated clay.

W-862 Fort Garry II

uncorrected age: 6750 ± 320

The *Fraxinus* wood (identified by the Forest Product Laboratory) from 14.0 m depth was enclosed in clayey silt that underlies 1.5 m of silty clay and overlies 7.6 m of laminated clay.

The coordinates were given as 49°48'N and 97°12'W in the original date list (Rubin and Alexander, 1960, p. 175).

St. Vital Park Series

A series of samples from a terrace of the Red River at St. Vital Park, about 6 km south of the confluence with the Assiniboine River, Winnipeg, Manitoba (49°49'40"N, 97°08'50"W) was collected by E. Nielsen in September, 1983. These samples were submitted by E. Nielsen to gain information on fluvial processes, alluviation, and the rate of overbank sedimentation.

BGS-1342 St. Vital Park I

uncorrected age: 260 ± 70

The charcoal sample 'MM 1O D(a)' from a depth of about 50 cm was enclosed in overbank silt of a natural river exposure along Red River. The enclosing material was dry with some root penetration.

BGS-1343 St. Vital Park II

uncorrected age: 430 ± 70

The charcoal sample 'MM 1O D(c)' from a depth of about 87 cm was enclosed in overbank silt.

Comment (E. Nielsen): The natural river exposure along Red River where the sample was collected was dry with some root penetration. The date of sample will help to determine rate of overbank sedimentation on the terrace.

BGS-1346 St. Vital Park III

uncorrected age: 1400 ± 80

The charcoal sample 'MM 1O H(a)' from a depth of about 1.3 m was enclosed in overbank silt.

Comment (E. Nielsen): The sample was collected from a natural river exposure along the Red River. The enclosing materials were dry with some root penetration. The age of the sample will help to determine the rate of overbank sedimentation on a low terrace of Red River.

BGS-1344 St. Vital Park IV

uncorrected age: 2390 ± 70

The charcoal sample 'MM 1O G(b)' from a depth of about 3.3 m was enclosed in silt.

Comment (E. Nielsen): The sample was collected from a natural river exposure along the Red River. The enclosing materials were dry with some root penetration. The age of the sample will help to determine the rate of overbank sedimentation on the terraces of Red River.

BGS-1345 St. Vital Park V

uncorrected age: 2800 ± 80

The freshwater shells (*Lampsilis radiata siliquoidea*; identified by W.B. McKillop), sample 'MM 1O G(e)', from a depth of about 9.18 m were enclosed in calcareous silty-sandy sediments.

Comment (E. Nielsen): The sample was collected from a natural river exposure along the Red River, but originated from a higher level in the section. The enclosing sediments were highly calcareous with Paleozoic carbonates. The age of the sample will help to determine the rate of overbank sedimentation on the terraces of Red River.

The samples that were collected in a terrace of the Red River at St. Vital Park were from the following depths:

MM 1O D(a)	0.50m	260 ± 70	BGS-1342
MM 1O D(c)	0.87m	430 ± 70	BGS-1343
MM 1O H(a)	1.3m	1400 ± 80	BGS-1346
MM 1O G(b)	3.3m	2390 ± 70	BGS-1344
MM 1O G(e)	9.2m	2800 ± 80	BGS-1345

Discussion of series: "The sediments along the Red River are primarily mixtures of sand, silt and clay with little or no coarse sand or gravel. The generally fine texture of the alluvium reflects the fine grain size of the Lake Agassiz clay plain, which constitutes the bulk of the eroded sediment transported by the river. Due to the fine texture, poor exposure and general lack of diagnostic sedimentary structures, depositional environments are difficult to interpret. Where minor gravel or coarse sand is present it generally occurs in the lower part of the sedimentary sequence, and if present, large unionids also occur near the base of the sections. The upper part of the stratigraphy comprises poorly laminated sediments with small shells, bones, charcoal layers and buried soil profiles, indicative of overbank deposition.

Between 9.2 ka (Teller and Last, 1981) and 8.3 ka (GSC-1679; Ringrose, 1975) Glacial Lake Agassiz regressed into northern Manitoba subaerially exposing the Red River basin and at least part of the south basin of Lake Winnipeg (Ringrose, 1975). The Red River flowing into the south end of Lake Agassiz followed the regression northward and had excavated the present channel to a depth of 10-15 m by 7.5 ka and possibly earlier. The Assiniboine River flowed into the Red River and occupied the same channel at least near the confluence that it occupies today. In its early history, baselevel for the Red River was determined initially by the level of Lake Agassiz and later by the level of Lake Winnipeg. Upstream in

the Winnipeg area base level was controlled by the resistant till and the bedrock sill at Lockport, which became exposed once the river had cut through the Lake Agassiz sediment. On the basis of the present gradient of late Lake Agassiz beaches, about 5-8 m of differential uplift is estimated to have occurred over the 37 km distance between the south end of Winnipeg and Lockport (Johnston, 1946; Teller and Thorleifson, 1983). This would suggest that in the early Holocene the valley in the Lockport area may not have been excavated to the depth it is now, a conclusion supported by the much older radiocarbon dates from the Assiniboine River and the area south of the Assiniboine (7490 ± 80, 6750 ± 320) compared to the oldest radiocarbon dates north of the city (5260 ± 110, 5000 ± 100 rcybp). The history of overbank sedimentation exposed in the sediments of the Red River north of the confluence with the Assiniboine is markedly different from those exposed to the south.

South of the confluence with the Assiniboine the Red River is characterized by a wide flood plain, looping meanders and relatively high sedimentation rates. In the straight belt where there is a relatively narrow floodplain and little evidence of meandering, the sedimentation rates have been variable. Initial high sedimentation rates of 7.4 mm/yr between about 5.3 and 4.8 ka BP occur within the time period in which Rannie et al. (1989) speculated that the Assiniboine may briefly have joined the Red and is coincident with the time of gradual change to cooler and moister climate conditions. Work by Teller and Last (1981), Ritchie (1987), Ovenden (1990) and Kuhry et al. (1992) indicated that the climate prior to about 5.0 ka was significantly drier than after that time. Lake Manitoba was on occasion completely dry, and prairie grassland vegetation extended much further to the east and northeast during the warm and dry middle Holocene. Cooler and moister conditions at the end of the middle Holocene, coincident with the shift in the Assiniboine to its present location, as suggested by Rannie et al. (1989; their Long Lake-Flea Island Phase dated at about 4.8-5.2 ka), lead to bankfull and overbank conditions and high sedimentation rates. Sedimentation rates were initially high, but as the Assiniboine changed course and once again flowed into Lake Manitoba, overbank conditions only rarely occurred. The frequency of overbank conditions would have gradually increased through the late Holocene due to isostatic uplift of the sill at Lockport and the resulting decrease in the grade of the river. This condition may have been offset by increased precipitation and vegetation cover, resulting in decreased erosion after 4.5 ka (Kuhry et al., 1992). Also, by 4.5 ka when there was a sharp drop in the sedimentation rate on the Red, the Assiniboine was again flowing into Lake Manitoba and no longer contributing to the Red River. The increase in sedimentation rate to 1.1 mm/yr at 1.4-1.5 ka may be attributed to the shift in the Assiniboine drainage from Lake Manitoba back to the Red, or alternatively, a shift northward from the La Salle River and consequently greater proximity to the straight belt. The low sedimentation rates along the straight belt of the Red between 4.8 and 1.5 ka BP suggests the Assiniboine may have flowed into Lake Manitoba during this time. This conclusion is not supported by sedimentation rates along the meander belt nor by the work of Rannie et al. (1989) who concluded that the Assiniboine had joined the Red south of Winnipeg at the present site of the La Salle River about 3.0 ka and did not reoccupy the present location until about 1.3 ka BP.

The molluscan record provided insight into the magnitude and duration of highwater stands. The intensity of these floods varied, and while some were spring events with variable currents, others showed evidence of rapid currents and major flooding lasting well into mid-summer. At other times high water with little or no current extended into late summer and sometimes perennial high waters became the norm. It was this latter category that was most significant as it showed evidence of long term high water or backwaters frequently serving as bench marks for floods at other sites.

The two southern exposures provided information on the more recent periods of high waters while the three northern sites provided older records. The molluscan record supports the stratigraphic interpretation with large unionids and molluscs frequently associated with flowing waters commonly being found in coarse sandy layers, while backwater species were associated with finer sediments. When taken alone, the terrestrial species normally associated with damp woodland areas were found in horizons frequently showing soil development.

Conclusions:

Sedimentological and paleontological studies in association with radiocarbon dating indicate:

- the Red River has occupied the present position since the regression of Lake Agassiz between 9.2 and 8.3 ka BP;
- the Assiniboine and Red rivers had excavated their respective valleys by 7.5 ka BP;
- the Red River is entrenched throughout the study area and sedimentation is by vertical accretion during periods of flooding;
- in the straight belt, vertical accretion of sediments on the floodplain started about 5.2 ka BP, in response to increased precipitation and a brief eastward excursion of the Assiniboine River.
- at about 4.8 ka the course of the Assiniboine changed and it flowed north into Lake Manitoba; as a result the overbank sedimentation rate dropped to 0.1 mm/yr until about 1.4 ka BP;
- about 3.0 ka the Assiniboine River flowed eastward again to where the La Salle River joins the Red River today. This appears to have had little effect on the sedimentation rate in the straight belt farther downstream;
- the northward shift in the position of the Assiniboine River to its present position at about 1.4 ka and its closer proximity to the straight belt lead to an increase in the sedimentation rate to about 1.1 mm/yr;
- the overbank sedimentation rate in the meander belt, though based on limited data, was about 2 mm/yr between 3.0 and 1.4 ka BP.
- after 1.4 ka the rate fell to between 0.1 and 0.4 mm/yr as the Assiniboine River shifted northward to its present position." (Nielsen et al., 1993).

Ravenscourt Series

A series of samples from about 4.2 km south of the confluence of the Assiniboine and Red rivers, on the west side of the Red River in Winnipeg, Manitoba (49°50'35"N, 97°07'15"W) was collected by W.B. McKillop in September, 1983. Three sections outcropped along a 50 m stretch of the upstream end of a prominent meander lobe and revealed a widely varying stratigraphy. These samples were submitted by W.B. McKillop to gain information on fluvial processes, alluviation, and the rate of sedimentation.

BGS-919 Ravenscourt I

uncorrected age: 180 ± 100

The charcoal sample from Section C at a depth of 3.2 m was enclosed in horizontally bedded silt and silty clay. The Red River alluvium was 3.5 m-thick at this site.

BGS-922 Ravenscourt II

uncorrected age:

770 ± 100

The freshwater shells (Unionidae; identified by W.B. McKillop) from Section B at a depth of 2.3 m were enclosed in 30 cm-thick gravel bed overlying silt and sand and overlain by crossbedded sand. Red River alluvium was 4.5 m-thick at this site.

BGS-918 Ravenscourt III

uncorrected age: 1530 ± 100

The charcoal sample 'MM 26 A(a)' from a depth of 2.4 m was enclosed in laminated calcareous silt. The Red River alluvium was 6.2 m-thick consisting of interbedded silt and mixed charcoal.

BGS-1423 Ravenscourt IV

uncorrected age: 3120 ± 90

The freshwater shells (*Amblema plicata*; identified by W.B. McKillop) 'MM 26 A(a)' from a depth of 5.7 m was enclosed in laminated calcareous silt. The Red River alluvium was 6.2 m-thick consisting of interbedded silt and mixed charcoal.

Comment (B. McKillop): Section A, 6.3 m of moist sediment with no plant growth, was a clean and fresh section. These dates will help to indicate rate of sedimentation of alluvial sediment from the Red River.

BGS-1422 St. Boniface Hospital

uncorrected age: 1380 ± 80

The wood was enclosed in clay overlain by 7 m (23') of Red River alluvium. Sample 'St. Boniface 90-1'was collected by E. Nielsen on March 6, 1990, at the pumping station of the St. Boniface Hospital, Winnipeg, Manitoba (49°53'00"N, 97°07'40"W). This sample was submitted by E. Nielsen to gain information on fluvial processes, and alluviation along the Red River.

Comment (E. Nielsen): The collection site was at the pumping station. The sample was collected from the 7 m (23') level. The wood was associated with bison bones, and was wet and fragmented with no root penetration. This sample will help to determine sedimentation pattern along the Red River.

Bottomly Creek Series

A series of samples near the mouth of Bottomly Creek, on the east bank of the Red River, about 12.7 km north-northeast of the confluence of the Assiniboine and Red rivers, Manitoba (49°55'N, 97°05'W) was collected by G. Conley and W.B. McKillop in September, 1983. These samples were collected and submitted by E. Nielsen to gain information on the fluvial processes, alluviation, and paleobiology.

BGS-925 Bottomly Creek I

uncorrected age: 2370 ± 100

The *Bison* bone in Section B from 0.9 m depth was enclosed in silty clay beneath three paleosols. The date was on bone collagen.

BGS-924 Bottomly Creek II

uncorrected age: 4540 ± 100

The *Bison* bone in Section E from 1.3 m depth was enclosed in silty clay beneath two paleosols. The date was on bone collagen.

BGS-923 Bottomly Creek III

uncorrected age: 5260 ± 110

The freshwater shells of *Amnicola limnosa* (identified by W.B. McKillop) in Section C from 5.5 m depth were enclosed in clayey silt.

Comment (E. Nielsen): Five sections were examined along a 200 m exposure just upstream from the creek mouth. Bison bones from sections B and E were submitted for radiocarbon dating. A small piece of aboriginal pottery was recorded at a depth of 15 cm in section B, 75 cm above the bones dated by BGS-925.

BGS-1409 North Kildonan

uncorrected age: 1220 ± 70

The wood was enclosed in silty clay overbank sediments. Sample '88-71-1' from 9.0 m depth was collected by B. Bannatyne on March 1, 1971, from about 10.5 km north-northeast of the confluence of the Assiniboine and Red rivers at North Kildonan, about 200 m east of Red River, Winnipeg, Manitoba (49°56'05"N, 97°05'40"W). This sample was submitted by E. Nielsen to gain information on fluvial processes, alluviation, and rate of overbank sedimentation.

Comment (E. Nielsen): The collection site was a sewer excavation, about 10 m-deep winter excavation. The sample was wet and there was water in the hole. It will provide an age for the down cutting of the Red River after the drainage of Lake Agassiz, and also give a rate of overbank sedimentation along Red River.

S-588 East St. Paul

uncorrected age: 2995 ± 105

The bone sample 'CMC-385', from 105-120 cm depth, was collected by J. Mori on June 11, 1969, from the east side of the Red River, about 11.5 km north-northeast of the confluence of the Assiniboine and Red rivers, in East St. Paul, Manitoba (49°59'N, 97°03'W). This sample was submitted by J. Mori for collagen dating to gain information on fluvial processes, alluviation, and archaeology.

Comment (J. Mori): The site is stratified with Blackduck pottery in the upper levels, and it has been eroded by the river. S-588 is from a bison kill associated with a Larter tanged point. GaK-2746, from the Blackduck levels, was too small to be dated.

Lockport Series

A series of samples near the Red River Floodway mouth at Lockport, on the east bank of the Red River, about 26 km north-northeast of the junction of the Assiniboine and Red rivers, Manitoba (50°05'N, 96°55'W) was collected in 1984, 1985, and 1986. These samples were submitted by A.P. Buchner to gain information on fluvial processes, alluviation, and archaeology.

S-2850 Lockport I

uncorrected age: 470 ± 270

The charcoal sample from 0.37 m depth was at the contact of Beds B and C.

RIDDL-1273 Lockport II

normalized age: 705 ± 75

The bone sample was from 0.57 m depth. Bone collagen was dated.

S-2852 Lockport III

uncorrected age: 315 ± 235

The charcoal sample at 0.63 m depth originated from a higher level.

RIDDL-1272 Lockport IV

normalized age: 595 ± 80

The bone sample was from 0.78 m depth. Bone collagen was dated.

GX-10866 Lockport V

uncorrected age: 620 ± 105

The charcoal sample from 0.82 m depth was in Bed D.

S-2849 Lockport VI

uncorrected age: 635 ± 90

The charcoal sample from 0.83 m depth was at the contact of Beds D and E.

S-2851 Lockport VII

uncorrected age: 1005 ± 280

The charcoal sample from 0.75 m depth was at the contact of Beds E and F.

S-2853 Lockport VIII

uncorrected age: 1095 ± 250

The charcoal sample from 1.53 m depth was at the contact of Beds E and F.

S-2848 Lockport IX

uncorrected age: 1185 ± 255

The charcoal sample from 0.83 m depth was at the contact of Beds E and F.

S-2854 Lockport X

uncorrected age: 1185 ± 255

The charcoal sample from 0.93 m depth was at the contact of Beds E and F.

GX-10865 Lockport XI

uncorrected age: 1410 ± 290

The bone sample from 1.42 m depth was in Bed F. Bone collagen was dated.

GX-10864 Lockport XII

uncorrected age: 2315 ± 85

The bone sample from 1.57 m depth was at the contact of Beds G and H. Bone collagen was dated.

GX-10863 Lockport XIII

uncorrected age: 2515 ± 140

The *Bison* bone (vertebra) from 1.90 m depth was enclosed in Bed H. Bone collagen was dated.

S-2847 Lockport XIV

uncorrected age: 3300 ± 295

The charcoal sample from 2.10 m depth was at the contact of Beds H and I.

The samples collected at various times near the Red River Floodway mouth at Lockport, on the east bank of the Red River, are listed below:

charcoal	0.37m	470 ± 270	S-2850
bone	0.57m	705 ± 75	RIDDL-1273
charcoal	0.63m	315 ± 235	S-2852
charcoal	0.75m	1005 ± 280	S-2851
bone	0.78m	595 ± 80	RIDDL-1272
charcoal	0.82m	620 ± 105	GX-10866
charcoal	0.83m	635 ± 90	S-2849
charcoal	0.83m	1185 ± 255	S-2848
charcoal	0.93m	1185 ± 255	S-2854
bone	1.42m	1410 ± 290	GX-10865
charcoal	1.53m	1095 ± 250	S-2853
bone	1.57m	2315 ± 85	GX-10864
bone	1.90m	2515 ± 140	GX-10863
charcoal	2.10m	3300 ± 295	S-2847

Comment (A.P. Buchner): This site is unusually important for several reasons. It contains one of the few deeply stratified sequences in Manitoba. It has produced evidence of the northernmost aboriginal corn horticulture in Canada. It is well dated by a series of 14 radiocarbon measurements that aid the reconstruction of fluvial sedimentology and paleoecology in the Red River valley.

Parkes Creek Series

A series of samples from the west side of the Red River south of Parkes Creek, about 16.5 km north-northeast of the confluence of the Assiniboine and Red rivers, Manitoba (50°01'30"N, 97°02'15"W), at an elevation of 227 m, was collected in September, 1983 and on May 19, 1995. These samples were submitted by E. Nielsen to gain information on the fluvial processes and alluviation of the Parkes Creek section, and archaeology.

BGS-1801 Parkes Creek I

uncorrected age: 3625 ± 70

The bone sample in Section A from 0.75 m depth was enclosed in silty clay. The bone collagen was dated.

BGS-1802 Parkes Creek II

uncorrected age: 3940 ± 80

The bone sample in Section A from 1.06 m depth was enclosed in silty clay. The bone collagen was dated.

BGS-926 Parkes Creek III

uncorrected age: 3560 ± 100

The *Bison* bone sample in Section A from 1.4 m depth was enclosed in a paleosol in silty clay. Bone collagen was dated.

BGS-1803 Parkes Creek IV

uncorrected age: 4920 ± 100

The bone sample in Section A from 1.40 m depth was enclosed in silty clay. The bone collagen was dated.

BGS-1804 Parkes Creek V

uncorrected age: 5330 ± 80

The bone sample in Section A from 2.55 m depth was enclosed in silty clay. The bone collagen was dated.

BGS-921 Parkes Creek VI

uncorrected age: 5000 ± 100

The freshwater mollusc shells (Unionidae; identified by W.B. McKillop) in Section F from 3.4 m depth were enclosed in sand and gravel overlain by laminated silt and clay.

BGS-920 Parkes Creek VII

uncorrected age: 4980 ± 125

The freshwater mollusc shells (Unionidae; identified by W.B. McKillop) in Section A from 4.5 m depth were enclosed in sand and gravel overlain by laminated silt and clay.

The samples collected from the west side of the Red River south of Parkes Creek are listed below:

Section A		
0.75m	3625 ± 70	BGS-1801
1.06m	3940 ± 80	BGS-1802
1.40m	3560 ± 100	BGS-926
1.40m	4920 ± 100	BGS-1803
2.55m	5330 ± 80	BGS-1804
4.50m	4980 ± 125	BGS-920
Section F		
3.40m	5000 ± 100	BGS-921

St. Andrews Series

A series of samples from the east bank of the Red River opposite St. Andrews, about 24 km north-northeast of the confluence of the Assiniboine and Red rivers, Manitoba (50°03'50"N, 96°58'25"W), was collected by E. Nielsen. These samples were submitted by E. Nielsen to gain information on fluvial processes and alluviation of the St. Andrews section, and paleobiology.

BGS-927 St. Andrews I

uncorrected age: 3630 ± 100

The bones, *Bison* ribs and vertebrae, from 2.0 m depth in a 3.2 m section, were enclosed in paleosol in silty clay and silty sand. The bone collagen was dated.

Comment (E. Nielsen): A 3.2 m section is believed to have been deposited by overbank sedimentation during floods spanning the last 5000 years. Bison bones from a paleosol were submitted for a radiocarbon date.

BGS-917 St. Andrews II

uncorrected age: 4900 ± 100

The basal charcoal sample from 3.2 m depth in a 3.2 m section was at the base of 0.5 m-thick brown silty clay.

Comment (E. Nielsen): Six sections were examined along a 20 m stretch just upstream of the creek mouth. Bison bones from section A were submitted for radiocarbon dating. This section exposed four prominent soils, four bone horizons, two charcoal layers, and two reddish-brown zones formed by burning. It was subsequently investigated as an archaeological site, situated at what is now the largest and most prominent rapids on the Red River.

Radiocarbon Dates on southern rivers

GSC-4712 St. Labre

normalized age: 420 ± 60
$\delta^{13}C$= -25.0‰
uncorrected age: 420 ± 60

The wood (*Salix*; identified by H. Jetté (unpublished GSC Wood Report No. 88-37)) was enclosed in sand. Sample 'G468F' was collected by G. Matile on June 19, 1986, from 7 km north-northwest of St. Labre, southeast Manitoba (49°23'16"N, 96°03'01"W), at an elevation of 340 m. This sample was submitted by G. Matile to gain information on alluviation.

Comment (G. Matile): This sample dates recent alluvial activity.

BGS-1224 Souris River

normalized age: 1910 ± 80
$\delta^{13}C$= -8.85‰
uncorrected age: 1650 ± 80

The freshwater shells were enclosed in coarse sand with a large amount of lignite fragments throughout the section. Sample 'HG 956' was collected by H. Groom on July 22, 1987, from the bank on east side of Souris River on Hartney golf course, 4 km north of

Hartney, Manitoba (49°32'N, 100°29'W), at an elevation of 426 m. This sample was submitted by E. Nielsen to gain information on lake level change of Lake Souris.

Comment (H. Groom): The shells were found throughout the upper 2.5 m of the section but were usually concentrated in pockets of coarse sand. The site is in the basin of Glacial Lake Souris, although the sand is probably reworked alluvium.

GSC-5686 Hazel Creek

normalized age: 2010 ± 50
$\delta^{13}C$= -25.6‰
uncorrected age: 2020 ± 50

The wood (*Larix*; identified by H. Jetté (unpublished GSC Wood Report No. 92-06)) was enclosed in the base of 1.2 m of interbedded medium to coarse sand and silty fine sand. Sample '93 M74 0819 (1.2 m)' was collected by G. Matile and L.H. Thorleifson on August 18, 1993, from the abandoned upper reaches of Hazel Creek, 3 km north-northwest of Hadashville, Manitoba (49°42'02"N, 95°55'49"W), at an elevation of 295 m. This sample was submitted by G. Matile to gain information on alluviation.

Comment (G. Matile): The wood was collected from the base of a 1.2 m-shovel hole at the edge of a cultivated field. The water table was at 0.9 m. The enclosing material contained abundant Paleozoic carbonate clasts, shells and charcoal which may or may not be of the same age. There was a buried 'A horizon' at 0.2 m. In addition to the log the sediment contained disseminated charcoal and numerous bivalves. The sediments are interpreted as alluvium. A wood sample from a river terrace 8 km up stream on the Whitemouth River dated 7.1 ka BP (BGS-1424 in section related to the 'Moorhead Phase' of Lake Agassiz).

GSC-1424 Neepawa

normalized age: >37 000

The organic sand was enclosed in horizontally bedded sand containing some armoured clay balls. Sample 'E 69-C-18' was collected by J.A. Elson on August 17, 1969, from a roadcut on the east side of highway 258, 4.0 km south of Neepawa, Manitoba (50°11'20"N, 99°27'12"W), at an elevation of 377 m. This sample was submitted by J.A. Elson to gain information on alluviation.

Comment (J.A. Elson): The silt and sand unit was interpreted as part of the earliest Assiniboine River delta deposited in Glacial Lake Agassiz. The deposit may be older than was thought, or more probably organic particles and armoured clay balls are derived from older Pleistocene sediments.

GSC-346 Grandview

uncorrected age: 1670 ± 130

The charred material, charcoal, was enclosed in the base of a 1 m-thick clay unit overlying till. Sample 'KJ-7-63' was collected by R.W. Klassen on June 28, 1963, from the bank of a stream channel, Grandview, Manitoba (51°02'N, 100°31'W). This sample was submitted by R.W. Klassen to gain information on alluviation.

Comment (R.W. Klassen): The young age suggests that the clay is alluvial rather than a deposit of Glacial Lake Agassiz.

BGS-1100 Swan River

uncorrected age: 6960 ± 100

The bison bone was enclosed in calcareous silt. Sample 'Bone EN-85-1' was collected by E. Nielsen on June 1, 1985, from a natural river cut along the Swan River, Manitoba (52°00'N, 101°28'W), at an elevation of about 366 m. This sample was submitted by E. Nielsen to gain information on alluviation, and the incision of the river terrace.

BGS-1041 Swan River

normalized age: 3240 ± 80
$\delta^{13}C$= -12.6‰
uncorrected age: 3040 ± 80

The freshwater pelecypod shells (*Lampsilis radiata siliquoidea*; identified by W.B. McKillop) were enclosed in calcareous gravel. Sample 'EN No. 2' was collected by E. Nielsen on August 2, 1985, from 3 m-high river terrace on the Swan River, Manitoba (52°09'15"N, 101°09'10"W), at an elevation of 290 m. This sample was submitted by E. Nielsen to gain information on the fluvial history.

BGS-728 Bowsman

uncorrected age: 5350 ± 120

The bone was enclosed in silty clay. Sample 'EN-261' was collected by E. Nielsen on August 20, 1979, from along roadside ditch, 6.4 km west of Bowsman, Manitoba (52°13'N, 101°19'W). This sample was submitted by E. Nielsen to gain information on alluviation, and the rate of sedimentation.

BGS-595 Bellsite

uncorrected age: 680 ± 80

The basal wood was enclosed in 2 m of fine-textured alluvium in a fan overlying gravel. The sample was collected by G. Conley in 1979, from near Bellsite along eastern Porcupine Hills, Manitoba (52°35'45"N, 101°03'15"W). This sample was submitted by G. Conley to gain information on alluviation, and fan development.

Bellsite Series

A series of wood samples from highway 10, 4.5 km north of Bellsite, Manitoba (52°38'00"N, 101°05'50"W), was collected by E. Nielsen on August 2, 1985, and June 12, 1990. These samples were submitted by E. Nielsen to gain information on a landslide.

BGS-1040 Bellsite I

uncorrected age: 340 ± 70

The poplar wood (identified by E. Nielsen), sample 'EN #3', was enclosed in sand.

BGS-1438 Bellsite II

uncorrected age: 380 ± 80

The wood sample 'Mafeking 90-1' was believed to have been slumped out of the toe of a large landslide.

Comment (E. Nielsen): The collection site had no plant growth and was subjected to natural exposure. Some minor root hairs may be present. The second sample was not in place, but both date the landslide activity.

Radiocarbon Dates on northern rivers

GSC-5880 Minago River

normalized age: 2530 ± 70
$\delta^{13}C$= -29.0‰
uncorrected age: 2590 ± 70

The basal sedge and moss peat was enclosed in the lowermost 3-cm of peat directly overlying dolomitic bedrock. Sample '93-MOB-0061' from 72-75 cm depth was collected by I. McMartin and R. Boucher on June 15, 1993, from the Minago River channel, 3 km northeast of South Moose Lake, 100 km north-northwest of Grand Rapids, north-central Manitoba (54°04'09"N, 99°34'54"W), at an elevation of 259 m. This sample was submitted by I. McMartin to gain information on fluvial processes, and provide a minimum age for channel abandonment.

Comment (I. McMartin): This basal fen peat age in the abandoned Minago River channel is anomalously young compared to dates from the same context in the region (GSC-6052 in the section on 'Peat', and TO-4910 and -5700, below). The sample was collected at the highest rock-bottom altitude of the channel (259 m), directly on the present-day drainage divide between waters flowing into the Saskatchewan River and those flowing into the Minago River, providing a minimum age for channel abandonment. However, this site was probably not the most favourable for peat accumulation and the age obtained on limnic peat at the bottom of the channel (GSC-6087) is favoured for a minimum age of channel abandonment.

TO-4910 Minago River

normalized age: 5860 ± 60

The freshwater shells (*Pisidium*; identified by J-M. Gagnon) were enclosed in calcareous alluvial sediments. Sample '92-MOB-0011' was collected by I. McMartin on July 5, 1992, from Minago River channel, 400 m north of the Minago River, 100 km north of Grand Rapids, north-central Manitoba (54°12'05"N, 99°10'04"W), at an elevation of 235 m. This sample was submitted by I. McMartin to gain information on alluviation, and the diversion of the Saskatchewan River.

The age is normalized to a $\delta^{13}C$ of -25‰.

Comment (I. McMartin): This date is probably not significant in terms of a minimum age for channel abandonment. This site is 5 m above the bottom of the channel, and was therefore abandoned earlier than the rest of the channel.

Minago River Series

A series of samples from 50 m west of highway 6 and 150 m east of Wigle Lake, about 1 km north of the Minago River in the northern arm of the Minago River channel, north-central Manitoba (54°12'30"N, 99°10'10"W), at an elevation of 227 m, was collected by I. McMartin and S. Phaneuf on June 15, 1995. This sample was submitted by I. McMartin to gain information on alluviation, fluvial processes, and channel abandonment.

GSC-6077 Minago River I

normalized age: 4650 ± 90
$\delta^{13}C$= -25.56‰
uncorrected age: 4660 ± 90

The limnic peat sample '95-MOB-0043' from 2.34-2.36 m depth, (Unit B1) was enclosed in limnic peat immediately above fossiliferous limnic peat (Unit B2). Duplicate McCaulley peat cores taken in a fen bog (Minago River channel) were fairly uniform with well preserved sedges. The surrounding vegetation is *Carex*, *Salix* and *Larix*.

Comment (I. McMartin): The date provides an approximate age for a major change in depositional environment, from alluvial to shallow lacustrine, when limnic peat started to accumulate following the diversion of the Saskatchewan River.

GSC-6087 Minago River II

normalized age: 4500 ± 130
$\delta^{13}C$= -27.13‰
uncorrected age: 4540 ± 130

The limnic peat sample '95-MOB-0044' from 2.36-2.40 m depth, (Unit B2) was enclosed in limnic peat with freshwater shells immediately overlying alluvial sediments (Unit C). Duplicate McCaulley peat cores taken in a fen bog (Minago River channel) were fairly uniform with well preserved sedges. The surrounding vegetation is *Carex*, *Salix* and *Larix*.

Comment (I. McMartin): This date can be compared with an AMS radiocarbon age of 4880 ± 60 rcybp (TO-5699) obtained on freshwater mollusc shells from the same layer. Therefore about 380 years must be subtracted from mollusc dates in the area to make them comparable to other terrestrial materials. This date provides a minimum age for channel abandonment by the Saskatchewan River.

TO-5699 Minago River II

normalized age: 4880 ± 60

The freshwater gastropod shells (*Gyraulus*; identified by J-M. Gagnon), sample '95-MOB-0045' from 2.36-2.40 m depth (Unit B2), were enclosed in limnic peat.

The age is normalized to a $\delta^{13}C$ of -25‰.

Comment (I. McMartin): The sample is immediately above a unit composed of alluvial sediments (Unit C) and enclosed in a unit of dark brown organic limnic sediments (Unit B2). When compared

with a conventional radiocarbon date (GSC-6087) of 4500 ± 130 rcybp on the limnic peat enclosing these shells, a correction factor of about 380 years should be applied to mollusc dates from this region. This would compensate for the 'hardwater error' related to the calcareous sediments of the area and make the freshwater shell dates comparable with the peat dates.

TO-5700 Minago River III

normalized age: 5210 ± 60

The freshwater gastropod shells (*Gyraulus*; identified by J-M. Gagnon) sample '95-MOB-0046' from 2.40-2.46 m depth (Unit C), were enclosed in alluvial silts.

The age is normalized to a $\delta^{13}C$ of -25‰.

Comment (I. McMartin): The sample was enclosed in grey, calcareous (20% carbonate), sandy silt with aquatic organic fragments. This unit (Unit C) is interpreted as alluvium deposited by slow-moving waters of the Saskatchewan River before the final abandonment of the channel. By applying a 'hardwater' correction of about 380 years (cf. TO-5699 and GSC-6087), an approximate age of 4830 rcybp is obtained for this sample and thereby provides a maximum age for channel abandonment by the Saskatchewan River. The surrounding vegetation is composed of *Carex, Salix* and *Larix*.

GSC-1745 Hayes River

uncorrected age: 4890 ± 140

The wood (*Picea*; identified by R.J. Mott (unpublished GSC Wood Report No. 72-23)) was enclosed in alluvial or deltaic sand. Sample 'KJ-56-72' was collected by J.A. Netterville on June 9, 1972, from lower Hayes River, Hudson Bay Lowlands, northeastern Manitoba (56°45'N, 92°42'W), at an elevation of 21 m. This sample was submitted by R.W. Klassen to gain information on alluviation.

Comments (R.W. Klassen): The date indicates that this part of Hayes River valley is considerably less than 5000 years old (Klassen and Netterville, 1973).

GSC-2632 North Knife River

uncorrected age: 2560 ± 100

The wood and organic detritus (*Alnus* and *Salix*; identified by R.J. Mott (unpublished GSC Wood Report No. 77-62)) was enclosed in sand. Sample 'DU-77-456' was collected by L.A. Dredge and M. Nixon on August 3, 1977, on the east bank of the North Knife River near 'Olson Rapids', northeastern Manitoba (58°24'N, 96°49'W), at an elevation of 245 m. This sample was submitted by L.A. Dredge to gain information on alluviation.

Comment (L.A. Dredge); The date provides a maximum age for the glaciolacustrine silts and a minimum age for the North Knife river system, but was considerably younger than expected. The sample was examined by R.J. Richardson and appeared to be a forest litter containing wood, beetles, and plant remains.

RADIOCARBON DATES RELATED TO PEAT DEVELOPMENT[1] (Figs. 7a and 7b)

S-2468 Sprague Lake

uncorrected age: 3685 ± 240

The basal peat was enclosed in peat overlying mineral soil. The sample from 350 cm depth was collected by S.C. Zoltai in 1982, from northwest of Sprague Lake in the Lake of the Woods area, southeastern Manitoba (49°24'N, 95°22'W). This sample was submitted by S.C. Zoltai to gain information on peat accumulation.

Consult S-2473 (below, p. 41) for comments.

BGS-727 Marchand

uncorrected age: 31 000 ± 1000

The basal peat was overlying a boulder lag on a 3 m-thick bed of sand. Sample 'GB 258' from 1.9 m depth was collected by G. Matile on October 10, 1980, from 3 km south of Marchand, about 20 km from Steinbach, southeastern Manitoba (49°24'53"N, 96°24'55"W), at an elevation of 305 m. This sample was submitted by G. Matile to gain information on the initiation of peat deposition.

Comment (G. Matile): The peat horizon was intercepted with a backhoe at a depth of 1.9 m which was below the water table. The enclosing material was oxidized. The boulder lag which overlies the sand is probably a remnant of the Interlake Till, making the age of the peat about 30 ka BP.

Winnipeg River Series

A series of peat samples from south of the Winnipeg River about 133 km east of Winnipeg, southeastern Manitoba (49°49'N, 95°18'W) was collected by S.C. Zoltai in 1982. These samples were submitted by S.C. Zoltai to gain information on peat accumulation.

S-2466 Winnipeg River I

uncorrected age: 3240 ± 235

The basal peat sample from 205 cm depth was enclosed in peat overlying organic lacustrine sediment.

Peat accumulation rate is 6.3 cm/100 yr (Zoltai et al., 1988). Consult S-2473 (below, p. 41) for additional comments.

S-2467 Winnipeg River II

uncorrected age: 4980 ± 270

The basal lake sediment from 470 cm depth was enclosed in lake sediment overlying mineral soil.

Accumulation rate is 15.2 cm/100 yr. Consult S-2473 (below, p. 41) for additional comments.

Elma Series

A series of peat samples from a bog, 3.2 km southwest of Elma, Manitoba (49°53'N, 95°54'W) was collected by R. Reader and J. Stewart. These samples were submitted by R. Reader to gain information on the rate of peat accumulation.

BGS-13 A Elma I

uncorrected age: 2960 ± 75

The peat sample from 80-85 cm depth was enclosed in peat overlying clay at about 120 cm depth which overlies quartz pebbles and silt.

Comment (R. Reader): The core was taken in a peat bog, and a zone of predominantly *Carex* ('lag' zone) was sampled. The accumulation rate of peat at this site is 0.0279 cm/yr or 51.7 g/m^2/yr.

BGS-13 B Elma II

uncorrected age: 4525 ± 125

The peat sample from 185-190 cm depth was enclosed in peat overlying clay at about 240 cm depth.

Comment (R. Reader): The core was taken in a peat bog, and a zone of predominantly *Sphagnum* peat ('bog forest' zone) was sampled. The accumulation rate of peat at this site is 0.0414 cm/yr or 36.3 g/m^2/yr.

BGS-13 C Elma III

uncorrected age: 7940 ± 100

The peat sample from 200-205 cm depth was enclosed in peat overlying clay at about 220 cm depth.

Comment (R. Reader): A core was taken in a peat bog and a zone of predominantly *Sphagnum* peat ('muskeg' zone) was sampled. The accumulation rate of peat at this site is 0.0255 cm/yr or 26.8 g/m^2/yr.

I-1086 'Julius' Bog

uncorrected age: 2205 ± 500

The peat (*Sphagnum*; identified by J.C. Ritchie) sample was enclosed in peat. The sample from 2.4 m depth was collected by J.C. Ritchie in 1960, from 'Julius' Bog, 30 km southeast of Beausejour along the CPR railway line, Manitoba (49°59'44"N, 96°08'55"W), at an elevation of 284 m. This sample was submitted by J.C. Ritchie to gain information on peat accumulation.

[1] The locality descriptions for the samples collected by S.C. Zoltai were derived by McNeely from the coordinates provided by the submitter.

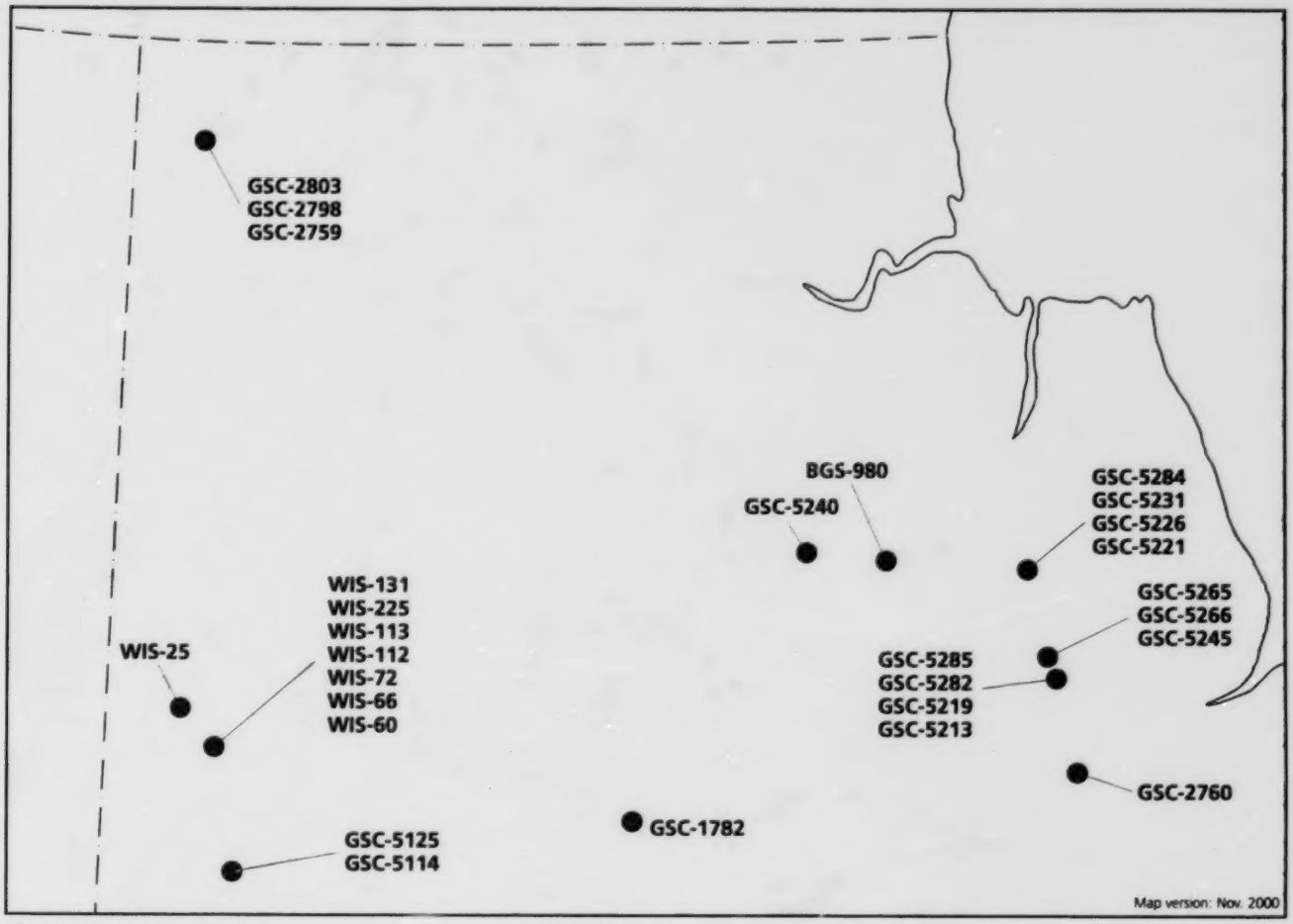

Figure 7a. Radiocarbon dates on peat deposits in northern Manitoba.

White Lake Series

A series of peat samples from south of the Winnipeg River in the White Lake area, about 70 km east of Beausejour, southeastern Manitoba (50°04'N, 95°33'W) was collected by S.C. Zoltai in 1982. These samples were submitted by S.C. Zoltai to gain information on the rate of peat accumulation.

S-2469 White Lake I

uncorrected age: 3210 ± 130

The basal peat sample from 172 cm depth was enclosed in peat overlying organic lacustrine sediment.

The accumulation rate is 5.4 cm/100 yr (Zoltai et al., 1988).

S-2470 White Lake II

uncorrected age: 5400 ± 170

The basal lake sediment from 230 cm depth was enclosed in lake sediment overlying mineral soil.

The accumulation rate is 2.7 cm/100 yr. (Zoltai et al., 1988). Consult S-2473 (below, p. 41) for additional comments.

I-8048 Lac du Bonnet

uncorrected age: 2670 ± 90

The amorphous black peat was overlain by fibrous amorphous peat, fibrous woody peat and *Spaghnum* dominated peat. The sample from 2.6 m depth was collected by J. Stewart in 1974, from 200 m west of 'ground zero' (end of boardwalk), 11 km south of Lac du Bonnet in Whiteshell Nuclear Research Establishment, north of highway 211, southeastern Manitoba (50°23'N, 95°54'W). This sample was submitted by J. Stewart to gain information on the peat development.

Pine Falls Series

A series of peat samples from north of the Winnipeg River about 55 km east of Pine Falls, southeastern Manitoba (50°35'N, 95°27'W) was collected by S.C. Zoltai in 1982. These samples were submitted by S.C. Zoltai to gain information on peat accumulation.

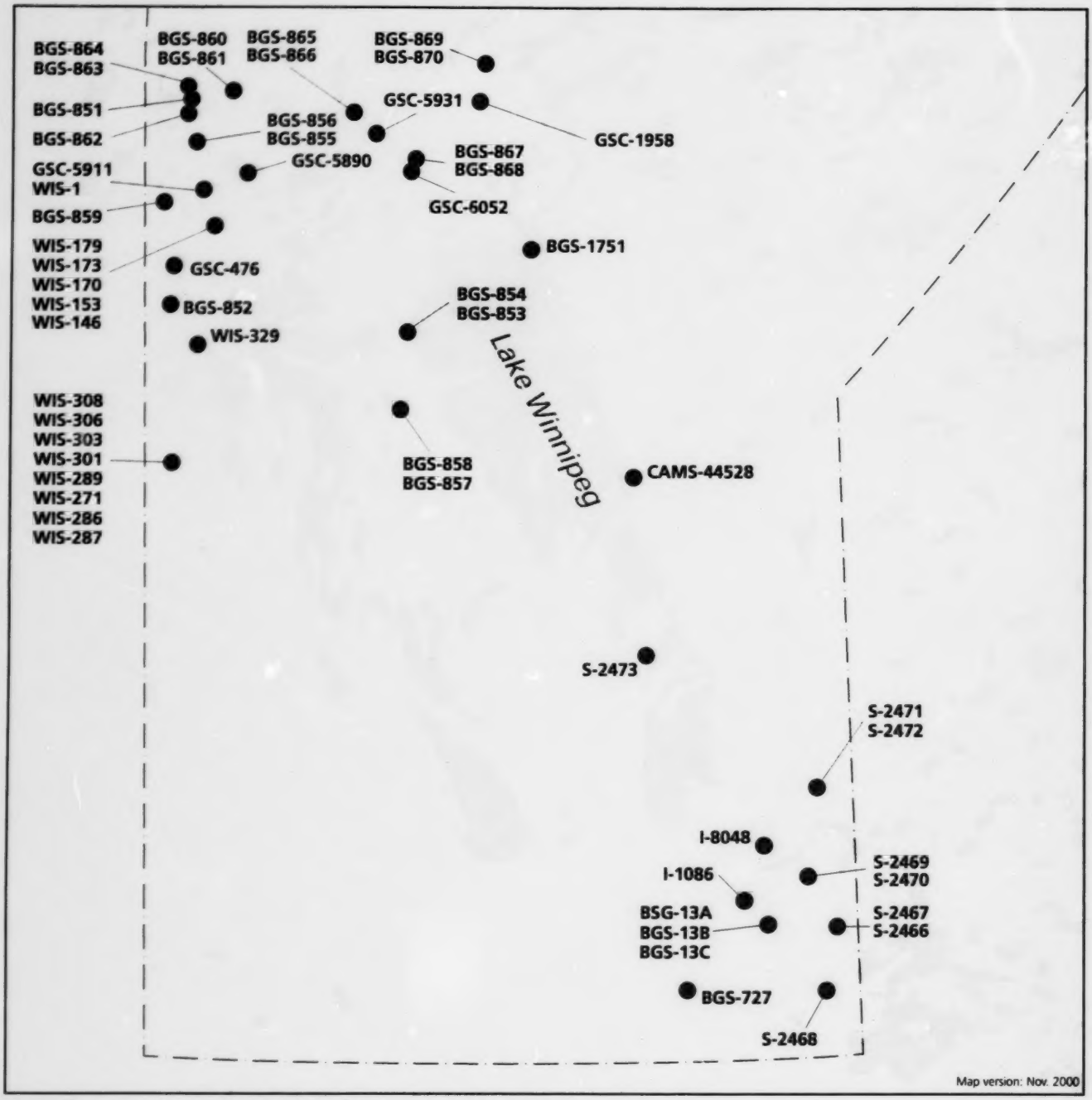

Figure 7b. Radiocarbon dates on peat deposits from southern Manitoba.

S-2471 Pine Falls I

uncorrected age: 4275 ± 255

The basal peat from 390 cm depth was enclosed in peat overlying organic lacustrine sediment.

The peat accumulation rate is 9.1 cm/100 yr (Zoltai et al., 1988). Consult S-2473 (below, p. 41) for additional comments.

S-2472 Pine Falls II

uncorrected age: 6120 ± 310

The basal lake sediment from 590 cm depth was enclosed in lake sediment overlying mineral soil.

The peat accumulation rate is 10.8 cm/100 yr (Zoltai et al., 1988). Consult S-2473 (below, p. 41) for additional comments.

S-2473 Beaver Creek

uncorrected age: 4340 ± 155

The basal peat was enclosed in peat overlying mineral soil. The sample from 459 cm depth was collected by S.C. Zoltai in 1982, from near Beaver Creek in the Washow Bay area, south basin of Lake Winnipeg, southern Manitoba (51°25'N, 96°53'W). This sample was submitted by S.C. Zoltai to gain information on peat accumulation.

Comment (S.C. Zoltai): "The Glacial Lake Agassiz basin, occupying most of the present area of Manitoba and large parts of Saskatchewan and Ontario, merits special consideration. In Canada, the lake was established following the melting of glacial ice about 11 000 years BP (Fenton et al., 1983), its level dropping as new, lower outlets became available. Southern Manitoba became dry land about 9200 years ago, but the lake covered most of central and large parts of Saskatchewan and Ontario until about 8700 years BP (Klassen, 1983b). It finally disappeared from the central part of the basin about 7500 years BP. Consequently, the basin became available for wetland formation much earlier in the south (9200 years BP) than in the north (7500-8000 years BP). Post glacial climate, according to pollen analyses (Ritchie, 1983), was initially cool; from 13 000 to 10 000 years BP, the mean summer temperature was 5-10°C, compared to the modern mean summer temperature of 13.5°C. Between 10 000 and 6500 years BP, the climate became warm and dry, with summer temperatures of 15-17°C and with 10-20% less precipitation than at present. The period between 6500 and 3000 years BP was equally warm, but precipitation increased to levels near those of the present. About 2500 years BP, the present climatic regime was established in the Glacial Lake Agassiz region. Last and Teller (1983) found that the sediments of Lake Manitoba, a large remnant of Glacial Lake Agassiz, indicate an end of the dry period about 4500 years BP. Radiocarbon dates show that peat deposition was delayed after glaciation by up to 5000 years. This appears to support the contention that the climate was not suitable for peat formation after the disappearance of Glacial Lake Agassiz, being warmer and drier than at present. Peat formation became possible between 4800 and 4300 years BP in the north and between 3700 and 3200 years BP in the southern part of the basin. It appears that the delay in establishing peatlands, caused by the presence of Glacial Lake Agassiz, came at a critical time for peatland establishment. If already established, the peatland flourished during the warmer and drier period, but new ones could not develop in the basin. Peatlands also formed in early times in other parts of the boreal wetland regions." (Zoltai et al., 1988).

CAMS-44528 Berens River

normalized age: 2910 ± 50

The mint seeds (*Mentha*; identified by A.M. Telka) were enclosed in basal firm black peat below sand, and over silt and granules and Agassiz clay. Sample '97301-008' from 33-34 cm depth was collected by D.L. Forbes, L. Hopkinson and F. Jodrey on March 22, 1997, north of the Berens River, off Disbrowe Point in the north basin of Lake Winnipeg, Manitoba (52°25.062'N, 97°06.965'W), at an elevation of 215.1 m. This sample was submitted by D.L. Forbes to gain information on the onshore beach, and initiation of peat accumulation.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Comment (A. Telka and D.L. Forbes): The dated mint seeds were from the base of peat unit (5-34 cm) below sand (0-5 cm) underlain by silt and granules (34-49 cm) and Agassiz clay (49-67 cm). The preservational state of the dated mint (*Mentha*) seeds was excellent. Unlike the dated top portion of the peat unit (see CAMS-44527 (p. 88) in the north basin of Lake Winnipeg) in which the majority of organics was wood, the unidentifiable organics within the base of the peat contain 'mats' of fine filamentous plant fragments. Shoreline indicators such as sedges (Cyperaceae), burreeds (*Sparganium*), grasses (Gramineae) and mints (*Mentha*) dominated the plant macrofossil assemblage with mints being the most abundant taxon. Tree species were almost absent with only one seed of birch (*Betula*) being observed. Insect fossil remains comprised mostly taxa which live among shoreline plants i.e., rove beetles (*Olophrum rotundicolle*) a species which is found among sedges at edges of lakes, bugs (Hemiptera) and marsh beetles (Helodidae). The age of 2.9 ka provides a basal age estimate for peat accumulation at this site and dates the termination of shallow-water deposition of silt and granules overlying the Agassiz Unconformity, about 2.9 m below the present lake level lakeward of the present beach on Disbrowe Point.

Core Stratigraphy:
Recovered 0.67 m of sediment from 1.07 m Hammer core in 2.6 m of water. The sample is from the base of peat unit (5-34 cm) below sand (0-5 cm) underlain by silt and granules (34-49 cm) and Agassiz clay (49-67 cm).

Fossil Arthropod and Plant Macrofossil Report: 98-07 (A.M. Telka)
Sample No.: 97301-008
Interval: 33-34 cm depth
Laboratory No.: 3-17
Water Depth: 2.6 m
Material: peat
Sample Vol.: 20 mL

PLANT MACROFOSSILS:		
Fungal Remains:		
fungal sclerotia	+	1
Vascular Plants:		
Sparganiaceae ..."bur-reed family"		
Sparganium sp.	+	seeds: 2
Gramineae ....."grass family"	+	seeds: 2
Cyperaceae ....."sedge family"	+	seeds: 2 (charred)
Carex lenticular type	+	seeds: 9 (two types)
Betulaceae ....."birch family"		
Betula sp.	+	seed: 1
Rosaceae ....."rose family"		
Potentilla sp.	+	seeds: 2
Violaceae ....."violet family"		
Viola sp.	+	half seeds: 5
Onagraceae ..."evening primrose family"		
Epilobium? sp. ..."willow herb"	+	seeds: 3
Labiatae ....."mint family"		
Mentha spp.	+++	small seeds: 77, large seed: 1
Compositae ...."composite family"	+	seeds: 2
Unidentified plant taxa	+	charred seed: 1, seed fragment: 1, unknown 'sac': 1
Other:		
charcoal	+	few fragments
wood	+	few fragments of 'punky' wood
net-veined leaves	+	fragments: 3
ANIMAL MACROFOSSILS:		
PORIFERA ....."sponges"		
HAPLOSCLERINA		
Spongillidae		
Spongilla type	+	3-cell clumps: 3
ARTHROPODA		
INSECTA		
HEMIPTERA ....."bugs"	+	head: 1, wing fragment: 1, pronotum: 1
COLEOPTERA ....."beetles"	+	pronota: 2, sternites: 10
Carabidae ....."ground beetles"	+	elytral fragments: 2, pronotum: 1

Bembidion sp.	+	pronotum: 1
Pterostichus sp.	+	head: 1
Staphylinidae ..."rove beetles"	+	elytra: 4
Omaliinae	+	head: 1
Olophrum rotundicolle (Sahlb.).	+	pronotum: 1
Olophrum sp.	+	elytron: 1
Stenus sp.	+	elytron: 1
Quedini	+	pronotum: 1
Helodidae ....."marsh beetles"	+	half elytra: 8, heads: 3 pronotum: 1
TRICHOPTERA ....."caddisflies"	+	larval trap: 1 (made of plant material)
DIPTERA ....."flies"	+	puparia: about 8
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	+	ephippia: 2
ARACHNIDA		
Oribatei/Acari .."mites"	+	3

Key: + = taxon present, +++ = taxon is abundant
-based upon examination of organics greater than 425 microns (0.425mm)

Porcupine Mountain Series

A series of peat samples from a peat bog in a kettle lake basin, Porcupine Mountain, Manitoba (52°31'N, 101°15'W), at an elevation of 640.2 m, was collected by R.A. Bryson and H. Nichols in 1967. These samples were submitted by H. Nichols to gain information on peat accumulation, and to provide chronology on a pollen diagram.

WIS-301 Porcupine Mountain I

uncorrected age: less than 250

The unhumified *Sphagnum* peat from 26-28 cm below the surface was enclosed in peat above clay at 207 cm.

WIS-287 Porcupine Mountain II

uncorrected age: 1170 ± 60

The basal *Sphagnum* peat from 50-52 cm below the surface was enclosed in peat above clay at 207 cm.

The peat accumulation rate is 4.3 cm/100 yr (Zoltai et al., 1988).

WIS-289 Porcupine Mountain III

uncorrected age: 2000 ± 55

The basal *Sphagnum* peat from 78-80 cm below the surface was enclosed in peat above clay at 207 cm.

The peat accumulation rate is 3.6 cm/100 yr (Zoltai et al., 1988).

WIS-303 Porcupine Mountain IV

uncorrected age: 2270 ± 60

The moderately humified *Sphagnum* peat from 100-102 cm below the surface was enclosed in peat with rootlets and wood above clay at 207 cm.

The peat accumulation rate is 7.4 cm/100 yr (Zoltai et al., 1988).

WIS-306 Porcupine Mountain V

uncorrected age: 2450 ± 60

The moderately humified *Sphagnum* peat from 116-118 cm below the surface was enclosed in peat above clay at 207 cm.

WIS-286 Porcupine Mountain VI

uncorrected age: 4180 ± 75

The basal detrital peat with rootlets from 144-146 cm below the surface was enclosed in peat above clay at 207 cm.

The peat accumulation rate is 2.3 cm/100 yr (Zoltai et al., 1988).

WIS-308 Porcupine Mountain VII

uncorrected age: 5140 ± 75

The basal detrital organic mud from 170-175 cm below surface was enclosed in peat above clay at 207 cm.

The peat accumulation rate is 2.6 cm/100 yr (Zoltai et al., 1988).

WIS-271 Porcupine Mountain VIII

uncorrected age: 6770 ± 70

The basal organic material, necron mud, from 205-210 cm below the bog surface was enclosed in clay below 207 cm.

Comment (H. Nichols): Basal samples were dated to (i) define the time of initiation of bog growth, and (ii) provide minimum dates for deglaciation. This date seems too late to indicate deglaciation which should have occurred prior to 9 ka BP. Although some time lapsed before the kettle formed, this sample only dates the onset of bog conditions. These samples were dated to develop chronologic control on structural changes within the peat monolith used for pollen analysis.

The average peat accumulation rate for the suite of samples is 3.3 cm/100 yr (Zoltai et al., 1988, p. 147).

Katimik Lake Series

A series of peat samples from near Katimik Lake, about 35 km south of Grand Rapids in the interlakes area of central Manitoba (52°54'N, 99°15'W) was collected by S.C. Zoltai in 1982. These samples were submitted by S.C. Zoltai to gain information on peat accumulation.

BGS-857 Katimik Lake I

uncorrected age: 925 ± 110

The peat sample 'No. 603 Site 28 B' from 85 cm depth was enclosed in fibric peat above mesic layer.

BGS-858 Katimik Lake II

uncorrected age: 7600 ± 110

The basal peat sample 'No. 612 Site 28 B' from 230 cm depth was enclosed in peat overlying mineral soil.

Consult S-2473 (above, p. 41) for additional comments.

WIS-329 'The Bog'

uncorrected age: 610 ± 60

The woody fen peat was enclosed in peat immediately overlying marl. The sample from 142-147 cm below the modern bog surface was collected by R.A. Bryson and H. Nichols in 1967, from 'The Bog', near The Pas, Manitoba (53°15'N, 101°06'W). This sample was submitted by R.A. Bryson to gain information on the peat.

Grand Rapids Series

A series of peat samples from Grand Rapids area, northern Lake Winnipeg, central Manitoba (53°18'N, 99°16'W) was collected by S.C. Zoltai in 1982. These samples were submitted by S.C. Zoltai to gain information on the peat accumulation.

BGS-853 Grand Rapids I

uncorrected age: 425 ± 100

The peat, sample 'No. 434 Site 22 A' from 80 cm depth was enclosed in mesic peat below a humic layer.

The peat accumulation rate is 6.7 cm/100 yr (Zoltai et al., 1988).

BGS-854 Grand Rapids II

uncorrected age: 4180 ± 120

The basal fen peat, sample '447 Site 22 A' from 282 cm depth was enclosed in peat overlying mineral soil.

The peat accumulation rate is 6.7 cm/100 yr (Zoltai et al., 1988). Consult S-2473 (above, p. 41) for additional comments.

BGS-852 Whithorn area

uncorrected age: 4550 ± 100

The basal fen peat was enclosed in peat overlying mineral soil. Sample 'No. 384 Site 21 A' from 338 cm depth was collected by S.C. Zoltai in 1982, from the Whithorn area, about 40 km southwest of The Pas, west-central Manitoba (53°28'N, 101°29'W). This sample was submitted by S.C. Zoltai to gain information on peat accumulation.

Consult S-2473 (above, p. 41) for additional comments.

BGS-1751 Warren Landing

uncorrected 3460 ± 80

The basal peat was enclosed in stratified peat (>1 m-thick) overlying Lake Agassiz clay. Sample 'Mossy Point No. 1' from 1.4 m depth was collected by E. Nielsen on August 22, 1994, from a shore cliff section 1 km south of Warren Landing, on the northeastern shore of the north basin of Lake Winnipeg, Manitoba (53°42'N, 97°55'W), at an elevation of about 220 m. This sample was submitted by E. Nielsen to gain information on the initiation of peat accumulation.

Comment (E. Nielsen): The sample dates the initiation of peat accumulation in the area.

GSC-476 The Pas

uncorrected age: 3050 ± 140

The peat was beneath 4.9 m of clayey alluvium of Saskatchewan River delta. Sample 'KJ-4&5-65' from 4.6 m depth was collected by R.W. Klassen on August 10, 1965, about 20 km southwest of The Pas, Manitoba (53°42'N, 101°23'W). This sample was submitted by R.W. Klassen to gain information on the rate of peat accumulation.

Comment (R.W. Klassen): The date indicates significant deposition over much of the delta in recent time.

Clearwater Lake Series

A series of peat samples from Clearwater Lake, west-central Manitoba (53°59'N, 101°12'W) was collected by R.A. Bryson in 1964. These samples were submitted by H. Nichols to gain information on the initiation of peat deposition, and provide chronology for microfossil analyses.

WIS-153 Clearwater Lake I

normalized age: modern

The *Sphagnum* peat sample from 26-30 cm below the surface was enclosed in peat overlying lacustrine beach sand at 80 cm depth. The peat 'Monolith' (80 cm section), beside the lake, was cut into 2-cm slices.

WIS-170 Clearwater Lake II

normalized age: modern

The *Sphagnum* peat sample from 62-63 cm below the surface was enclosed in peat and overlying lacustrine beach sand at 80 cm depth.

WIS-179 Clearwater Lake III

uncorrected age: 410 ± 60

The peat sample from 70-72 cm below the peat surface overlay lacustrine beach sand at 80 cm.

WIS-173 Clearwater Lake IV

uncorrected age: 940 ± 60

The basal *Sphagnum* peat from 78-80 cm below the peat surface overlay lacustrine beach sand at 80 cm.

The peat accumulation rate is 8 cm/100 yr (Zoltai et al., 1988).

Note: Zoltai et al., 1988 quoted the depth as 75 cm and coordinates as 52°53'N and 99°08'W.

WIS-146 Clearwater Lake V

uncorrected age: 1280 ± 75

The basal wood (*Picea*) from 80-82 cm depth was enclosed in peat overlying sand and overlain by 80 cm of *Sphagnum* peat.

Consult S-2473 (above, p. 41) for additional comments.

BGS-859 The Pas

uncorrected age: 4550 ± 100

The basal fen peat, sample 'No. 673 Site 30' from 330 cm depth, was enclosed in peat overlying mineral soil. The core was collected by S.C. Zoltai in 1982, about 30 km southwest of The Pas area, west-central Manitoba (54°05'N, 101°36'W). This sample was submitted by S.C. Zoltai to gain information on peat accumulation.

Consult S-2473 (above, p. 41) for additional comments.

Zoltai et al. (1988) gave the latitude as 54°04' which should be corrected to the above coordinates.

WIS-1 Root Lake

uncorrected age: 2380 ± 90

The basal peat, from a depth of 109 cm, was enclosed in peat overlying grey clay. The core was collected by R. Knollenberg in 1963, near Root Lake, 32 km north of The Pas, Manitoba (54°07'N, 101°17'W). This sample was submitted by R.A. Bryson to gain information on the initiation of peat deposition.

Comment (R.A. Bryson): This date indicates a surprisingly slow growth rate for the muskeg. Consult WIS-25 (below, p. 47) for additional comments.

GSC-5911 The Pas Moraine

normalized age: 1920 ± 60
$\delta^{13}C$= -27.6‰
uncorrected age: 1960 ± 60

The basal fen peat was overlying medium to fine grained and reduced glaciolacustrine sands. Sample '93-MOB-0064' from 143-145 cm depth was collected by I. McMartin and R. Bouchard on June 16, 1993, about 200 m in front of The Pas Moraine, west of the gravel road running along the crest of the moraine, trending northwest, and 9 km southeast of Wanless, north-central Manitoba (54°07'05"N, 101°16'44"W), at an elevation of 287 m. This sample was submitted by I. McMartin to gain information on the initiation of peat deposition.

Comment (I. McMartin): This basal bog peat age, in front of The Pas Moraine, is anomalously young compared to dates from the same area obtained on fen peat (BGS-852, -856, and -864), although it is similar to a date obtained from similar material in the same peat bog (WIS-1).

GSC-5890 Cormorant Lake

normalized age: 1400 ± 120
$\delta^{13}C$= -29.8‰
uncorrected age: 1470 ± 120

The basal fen peat was irregularly overlying fossiliferous alluvial silts. Sample '93-MOB-0062' from 160-180 cm depth was collected by I. McMartin and R. Boucher on June 15, 1993, from the southeast shore of Cormorant Lake, 200 m east of Cormorant Road (highway 287), 7.25 km southwest of Cormorant, north-central Manitoba (54°09'52"N, 100°39'07"W), at an elevation of 257 m. This sample was submitted by I. McMartin to gain information on the initiation of peat deposition.

Comment (I. McMartin): This basal fen peat age is surprisingly young and it would indicate a young age for the cessation of the overflowing of the Saskatchewan River in this part of the alluvial plain. Since the sample was taken in the old alluvial plain, this date should not be compared with other dates obtained on basal peat from the general area.

GSC-6052 Wigle Lake

normalized age: 4140 ± 90
$\delta^{13}C$= -30.50‰
uncorrected age: 4230 ± 90

The basal fen peat was enclosed in fen peat immediately above limnic peat (Unit B). Sample '95-MOB-0042' from 2.21-2.23 m depth (Unit A) was collected by I. McMartin and S. Phaneuf on June 15, 1995, from 50 m west of highway 6 and 150 m east of Wigle Lake, about 1 km north of the Minago River in the northern arm of the Minago River channel, north-central Manitoba (54°12'30"N, 99°10'10"W), at an elevation of 228 m. This sample was submitted by I. McMartin to gain information on peat accumulation.

Comment (I. McMartin): The date provides an estimate for the timing of a major change in the depositional environment from lacustrine to a sedge peat bog, after the diversion of the Saskatchewan River.

Wigle Lake Series

A series of peat samples from northeast of Wigle Lake, about 112 km north of Grand Rapids, central Manitoba (54°16'N, 99°09'W) was collected by S.C. Zoltai in 1982. These samples were submitted by S.C. Zoltai to gain information on peat accumulation.

BGS-867 Wigle Lake I

uncorrected age: 380 ± 100

The peat sample 'No. 1273 Site 57' from 53 cm depth was enclosed in fibric peat overlying a mesic layer.

BGS-868 Wigle Lake II

uncorrected 4900 ± 100

The basal fen peat sample 'No. 1284 Site 57' from 240 cm depth was enclosed in peat overlying mineral soil.

The peat accumulation rate is 4.9 cm/100 yr (Zoltai et al., 1988). Consult S-2473 (above, p. 41) for additional comments.

Atik Series

A series of peat samples from the Atik area, about 53 km northwest of The Pas, west-central Manitoba (54°18'N, 101°16'W) was

collected by S.C. Zoltai in 1982. These samples were submitted by S.C. Zoltai to gain information on peat accumulation.

BGS-856 Atik I

uncorrected age: 4640 ± 100

The basal fen peat sample 'No. 510 Site 24 B' from 256 cm depth was enclosed in peat overlying mineral soil.

The peat accumulation rate is 5.5 cm/100 yr (Zoltai et al., 1988).

BGS-855 Atik II

uncorrected age: 5300 ± 100

The peat sample 'No. 501 Site 24 B' from 108 cm depth was enclosed in mesic peat below a fibric layer.

Consult S-2473 (above, p. 41) for additional comments.

GSC-5931 Hargrave Lake

normalized age: 4930 ± 80
$\delta^{13}C$= -28.6‰
uncorrected age: 4980 ± 80

The basal fen peat was underlain by glaciolacustrine clay. Sample '92-MOB-0402' from 350-370 cm depth was collected by I. McMartin and S. Gautrey on August 7, 1992, from 4.25 km southeast of Hargrave Lake, 14 km southeast of Wekusko, north-central Manitoba (54°24'41"N, 99°36'42"W), at an elevation of 270 m. This sample was submitted by I. McMartin to gain information on the initiation of peat deposition.

Comment (I. McMartin): Several basal fen peat samples located in the surrounding peatlands have been radiocarbon dated between 4.6 and 5.0 ka BP. (BGS-868, above; GSC-1958, below; GSC-410, in the section on 'Pre-Holocene' dates), including this radiocarbon date at 4930 ± 80. These dates suggest a delay between the final drainage of Lake Agassiz and the establishment of fen peat forming vegetation over mineral soil, as discussed by Zoltai and Vitt (1990).

BGS-862 Simonhouse

uncorrected age: 8000 ± 150

The peat was enclosed in mesic peat under a fibric layer. Sample 'No. 821 Site 37 A' from 82 cm depth was collected by S.C. Zoltai in 1982, from southeast of Simonhouse about 15 km southwest of Cranberry Portage in central Manitoba (54°28'N, 101°26'W). This sample was submitted by S.C. Zoltai to gain information on peat accumulation.

Consult S-2473 (above, p. 41) for additional comments.

BGS-851 Flin Flon

uncorrected age: modern

The fibric peat was enclosed in peat overlying permafrost. Sample 'No. 328 Site 17 A' from 25 cm depth was collected by S.C. Zoltai in 1982, about 40 km south-southeast of Flin Flon, west-central Manitoba (54°31'N, 101°26'W). This sample was submitted by S.C. Zoltai to gain information on peat accumulation.

Wekusko Series

A series of peat samples from near Wekusko, about 105 km east of Cranberry Portage and about 150 km north of Grand Rapids in central Manitoba (54°33'N, 99°47'W) was collected by S.C. Zoltai in 1982. These samples were submitted by S.C. Zoltai to gain information on peat accumulation.

BGS-865 Wekusko I

uncorrected age: 700 ± 100

The peat sample 'No. 1056 Site 46 A' from 70 cm depth was enclosed in mesic peat over a humic layer.

BGS-866 Wekusko II

uncorrected age: 6500 ± 150

The basal peat sample 'No. 1076 Site 46 A' from 360 cm depth was enclosed in peat over mineral soil.

Consult S-2473 (above, p. 41) for additional comments.

Celery Lake Series

A series of peat samples from near Celery Lake, about 30 km east of Cranberry Portage in west-central Manitoba (54°35'N, 100°57'W) was collected by S.C. Zoltai in 1982. These samples were submitted by S.C. Zoltai to gain information on peat accumulation.

BGS-860 Celery Lake I

uncorrected age: 2200 ± 100

The peat sample 'No. 755 Site 35 A' from 60 cm depth was enclosed in mesic peat under a woody layer.

BGS-861 Celery Lake II

uncorrected age: 2860 ± 100

The basal peat sample 'No. 775 Site 35 A' from 355 cm depth was enclosed in peat over mineral soil.

Consult S-2473 (above, p. 41) for additional comments.

GSC-1958 Kiskitto Lake

uncorrected age: 4500 ± 120

The peat was at the base of a perennially frozen bog overlying lacustrine clay. Sample 'KJ-30-73' from 2.6 m depth was collected by R.W. Klassen on June 13, 1973, from Kiskitto Lake, north of Lake Winnipeg, Manitoba (54°36'N, 98°34'W), at an elevation of about 213 m. This sample was submitted by R.W. Klassen to gain information on Lake Agassiz drainage, and peat accumulation.

Comment (R.W. Klassen): The peat sample was from the bottom of a perennially frozen bog, 2.6 m-thick, forming part of an extensive organic blanket over a lacustrine clay. The sample was dated to obtain a more precise time for the drainage of Lake Agassiz in this region and to determine the rate of bog development. The age indicates probable sample contamination or that the bog began to develop long after Lake Agassiz had drained (about 8.5 ka BP); the

former explanation is considered most likely. Consult S-2473 (above, p. 41) for additional comments.

Cranberry Portage Series

A series of peat samples from west of Cranberry Portage, 85 km north of The Pas area, west-central Manitoba (54°36'N, 101°26'W) was collected by S.C. Zoltai in 1982. These samples were submitted by S.C. Zoltai to gain information on peat accumulation.

BGS-863 Cranberry Portage I

uncorrected age: 1200 ± 100

The peat sample 'No. 936 Site 40 A from 70 cm depth was enclosed in mesic peat under a humic layer.

BGS-864 Cranberry Portage II

uncorrected age: 2970 ± 100

The basal fen peat sample 'No. 963 Site 40 B' from 225 cm depth was enclosed in peat overlying mineral soil.

The peat accumulation rate is 7.6 cm/100 yr (Zoltai et al., 1988). Consult S-2473 (above, p. 41) for additional comments.

Wabowden Series

A series of peat samples from about 15 km southeast of Wabowden, and about 50 km west of Cross Lake townsite in central Manitoba (54°51'N, 98°30'W) was collected by S.C. Zoltai in 1982. These samples were submitted by S.C. Zoltai to gain information on peat accumulation.

BGS-869 Wabowden I

uncorrected age: 470 ± 100

The peat sample 'No. 1395 Site 63 B' from 85 cm depth was enclosed in mesic peat over a fibric layer.

BGS-870 Wabowden II

uncorrected age: 7600 ± 150

The basal peat sample 'No. 1413 Site 63 B' from 85 cm depth was enclosed in peat over mineral soil.

Consult S-2473 (above, p. 41) for additional comments.

Wheatcroft Lake Series

A series of samples from Wheatcroft Lake, 55 km southwest of Leaf Rapids, Manitoba (56°12'N, 100°42'W), at an elevation of 253 m, was collected by J. Danko in January, 1990. These samples were submitted by R.N.W. Dilabio and C. Kaszycki to gain information on peat geochemistry and peat accumulation.

GSC-5114 Wheatcroft Lake I

normalized age: 340 ± 100
$\delta^{13}C$= -26.7‰
uncorrected age: 370 ± 100

The moss and wood (twigs) sample 'WL-90-26' from 5.2 to 5.5 m (17.5-18') depth was enclosed in silt.

Comment (R.N.W. Dilabio and C. Kaszycki): The age is much younger than was anticipated. The organic materials may have been slumped into the lake bottom, and were probably not as deeply buried as originally estimated by the collector (also see GSC-5125).

GSC-5125 Wheatcroft Lake II

normalized age: 5540 ± 80
$\delta^{13}C$= -25.0‰
uncorrected age: 5540 ± 80

The lake sediment, silty with moss, sample 'WL-90-20' from 1.2 to 1.3 m (4-4.3') was enclosed in silt.

Comment (R.N.W. Dilabio and C. Kaszycki): The sample has a post- Lake Agassiz age, but younger than expected. The organic materials seem to be part of the normal Holocene lake sediment sequence in Wheatcroft Lake. They are younger than basal peat in the same region.

GSC-1782 Thompson

uncorrected age: 5430 ± 210

The lake sediment, basal organic material and moss (*Drepanocladus exannulatus* (about 90% of the mosses); identified by M. Kuc), was enclosed in the basal part of a moss and mossy gyttja layer below 270 cm which was overlain by algal gyttja. Sample 'MS-72-10' from 423-428 cm depth was collected by R.J. Mott on July 8, 1972, from a small unnamed kettle lake on a morainic ridge 82 km north of Thompson, northern Manitoba (56°28.6'N, 97°44'W), at an elevation of about 305 m. This sample was submitted by R.J. Mott to gain information on deglaciation, and peat accumulation.

Comments (R.J. Mott): Coring did not extend below the moss layer into the underlying organic sediment, and the date obtained is much too young for the time of deglaciation or emergence from a glacial lake. The date simply gives the age of the sediment (Mott, 1973).

GSC-2760 Gillam

uncorrected age: 6280 ± 80

The basal peat was enclosed in peat overlying 0.6 m-thick gravelly silty sand, overlying 4 m of clay. Sample 'R69-2-8' from 2.15-2.4 m depth was collected by E. Fraser on April 9, 1977, from a bog, 52 km northeast of Gillam, 3 km south of CNR siding at Charlebois, Manitoba (56°40'N, 94°05'W), at an elevation of about 122 m. This sample was submitted by D.W. Roggensack to gain information on the initiation of peat deposition.

Comment (D.W. Roggensack): The date represents the beginning of peat accumulation following the marine offlap of the Tyrrell Sea in the Hudson Bay Lowlands.

Comment (J.V. Matthews, Jr.): The plant fossils and fossil arthropods in this peat represent taxa that are found in and around the lakes of this region today.

Lynn Lake Series

A series of peat samples from near Lynn Lake in northwestern Manitoba (56°50'N, 101°03'W) was collected by H. Nichols in 1964. These samples were submitted by H. Nichols to gain information on peat accumulation, provide a chronology for microfossil, i.e. pollen data.

WIS-225 Lynn Lake I

uncorrected age: 1550 ± 50

The sedge (*Carex*) peat sample from 14-16 cm below the surface was enclosed in peat with humified moss peat above and sedge peat below.

WIS-113 Lynn Lake II

uncorrected age: 2170 ± 80

The sedge (*Carex*) peat sample from 34-36 cm below the surface was enclosed in peat overlying silty clay at about 130 cm depth.

WIS-131 Lynn Lake III

uncorrected age: 5600 ± 100

The sedge (*Carex*) peat sample from 58-60 cm below the surface was enclosed in peat overlying silty clay at about 130 cm depth.

WIS-112 Lynn Lake IV

uncorrected age: 5140 ± 100

The sedge (*Carex*) peat sample from 68-70 cm below the surface was enclosed in peat overlying silty clay at about 130 cm depth.

Comment (H. Nichols): A duplicate date from the same depth yielded an age of 5130 ± 100.

WIS-66 Lynn Lake V

uncorrected age: 5970 ± 110

The sedge (*Carex*) peat sample from 118-120 cm below surface was enclosed in peat overlying silty clay at about 130 cm depth.

WIS-60 Lynn Lake VI

uncorrected age: 6060 ± 110

The sedge (*Carex*) peat sample from 120-122 cm below the surface was enclosed in peat which overlies silty clay at about 130 cm depth.

WIS-72 Lynn Lake VII

uncorrected age: 6520 ± 130

The basal organic material from 130-140 cm below the surface was enclosed in lake mud above blue-grey silty clay.

Comment (H. Nichols): This date provides minimum age for local disappearance of late-Wisconsinan ice sheet.

General comment on series (H. Nichols): The organic material from this 1.5 m high peat section rested conformably on a grey-blue lacustrine clay deposited in a proglacial lake during the melting of late Wisconsin ice in this area. The peat monolith was divided into 2 cm-thick horizontal slices for macro- and microfossil analyses. Most of the section consisted of lake mud and sedge peat with sphagnum peat only in the top 20 cm. Samples were analyzed for pollen and spores and a pollen diagram has been constructed. Samples that reflect vegetational changes have been dated.

WIS-25 Zed Lake Road

uncorrected age: 340 ± 100

The *Sphagnum* peat sample, enclosed in unhumified peat, was collected from 111 cm depth by R. Knollenberg in 1963, 30 m from the edge of a string bog on Zed Lake Road, 24 km from Lynn Lake, in northwestern Manitoba (56°58'N, 101°16'W). This sample was submitted by R.A. Bryson to gain information on peat accumulation.

Comment (R.A. Bryson): Two samples were dated to obtain muskeg accumulation rates. WIS-25 was from a quite fresh unhumified string bog and suggests that the 4 to 5 m, a typical thickness of string bog deposits in the area, represent perhaps 2000 years of growth if some allowance is made for compression in the lower part of the bog. WIS-1, from the base of an upland muskeg, gives a similar age for its bog, but the accumulation rate is about 1/7 as great. These rather young ages for the initiation of muskeg growth are rather surprising.

Thibaudeau station Series

A series of peat samples from Thibaudeau station along the Hudson Bay Railway, 190 km south of Churchill, Manitoba (57°04.5'N, 94°09.5'W), at an elevation of 125 m, was collected by Manitoba Hydro in 1985. These samples were submitted by L.A. Dredge to gain information on peat accumulation, and climate change.

GSC-5282 Thibaudeau station I

normalized age: modern
$\delta^{13}C = -26.7‰$

The peat sample 'DU-91-1271' from 15-20 cm depth was enclosed in peat.

Comment (L.A. Dredge): The sample from the 15-20 cm depth, dates a 'Graminae level'.

GSC-5219 Thibaudeau station II

normalized age: 1140 ± 80
$\delta^{13}C = -25.3‰$
uncorrected age: 1140 ± 80

The peat sample 'DU-91-1272' from 38-43 cm depth was enclosed in peat.

Comment (L.A. Dredge): The sample from the 38-43 cm depth dates a change from spruce to sphagnum peat.

GSC-5285 Thibaudeau station III

normalized age: 4560 ± 110
$\delta^{13}C$= -25.2‰
uncorrected age: 4560 ± 110

The wood (*Picea*; identified by H. Jetté (unpublished GSC Wood Report No. 91-56)) sample 'DU-91-1274' from 65 cm depth was enclosed in peat.

Comment (L.A. Dredge): This wood sample was from 65 cm depth and indicates a forest interval.

GSC-5213 Thibaudeau station IV

normalized age: 6240 ± 80
$\delta^{13}C$= -29.4‰
uncorrected age: 6310 ± 80

The peat sample 'DU-91-1273' from 150-160 cm was enclosed in peat.

Comment (L.A. Dredge): This basal date from 150-160 cm below the surface, documents the initiation of organic accumulation at this site.

Silcox station Series

A series of peat samples from 5 km northwest of Silcox station along the Hudson Bay Railway, 175 km south of Churchill, Manitoba (57°10.0'N, 94°14.2'W), at an elevation of 135 m, was collected by Manitoba Hydro in 1985. These samples were submitted by L.A. Dredge to gain information on peat accumulation, and climate change.

GSC-5265 Silcox station I

normalized age: 550 ± 50
$\delta^{13}C$= -27.0‰
uncorrected age: 580 ± 50

The peat sample 'DU-91-521' from 20-25 cm depth was enclosed in peat.

Comment (L.A. Dredge): This sample from 20-25 cm depth dates the end of a 'Cyperaceae interval'.

GSC-5266 Silcox station II

normalized age: 1010 ± 60
$\delta^{13}C$= -28.3‰
uncorrected age: 1060 ± 60

The peat sample 'DU-91-522' from 38-43 cm depth was enclosed in peat.

Comment (L.A. Dredge): This sample from a depth of 38-45 cm dates the beginning of a 'Cyperaceae interval'.

GSC-5245 Silcox station II

normalized age: 3120 ± 60
$\delta^{13}C$= -25.9‰
uncorrected age: 3140 ± 60

The basal peat sample 'DU-91-523' from 70-75 cm was enclosed in peat.

Comment (L.A. Dredge): This basal sample from a depth of 70-75 cm was underlain by thin marine deposits and a silty stony till, and thus dates the initiation of peat accumulation at this site.

O'Day station Series

A series of peat samples from 6 km west of O'Day station (Lost Moose) along the Hudson Bay Railway, 130 km south of Churchill, Manitoba (57°33.9'N, 94°19.0'W), at an elevation of 110 m, was collected by Manitoba Hydro in 1985. These samples were submitted by L.A. Dredge to gain information on peat accumulation, and climate change.

GSC-5231 O'Day station I

normalized age: 290 ± 80
$\delta^{13}C$= -25.8‰
uncorrected age: 300 ± 80

The peat sample 'DU-91-1281' from 40-45 cm depth was enclosed in peat.

Comment (L.A. Dredge): This sample from 40-45 cm depth dates a change from spruce to sphagnum peat.

GSC-5226 O'Day station II

normalized age: 420 ± 90
$\delta^{13}C$= -26.9‰
uncorrected age: 460 ± 90

The peat sample 'DU-91-1282' from 50-55 cm depth was enclosed in peat.

Comment (L.A. Dredge): This sample from 50-55 cm depth dates the initiation of Ericaceae in the bog.

GSC-5284 O'Day station III

normalized age: 1980 ± 70
$\delta^{13}C$= -25.7‰
uncorrected age: 1990 ± 70

The peat sample 'DU-91-1283' from 68-73 cm depth was enclosed in peat.

Comment (L.A. Dredge): This sample from 68-73 cm depth dates the Cyperaceae zone.

GSC-5221 O'Day station IV

normalized age: 4270 ± 70
$\delta^{13}C$= -28.5‰
uncorrected age: 4320 ± 70

The peat sample 'DU-91-1284' from 125-135 cm depth was enclosed in peat.

Comment (L.A. Dredge): This basal sample from a depth of 125-135 cm dates the initiation of peat accumulation at this site.

General comments on Hudson Bay Lowlands Series (L.A. Dredge and R.J. Mott): Peat cores were extracted from three tundra sites along the Hudson Bay Railway south of Churchill which overlay raised marine deposits, and from the base of a 4-m forested peat section overlying Lake Agassiz clays at Bradshaw Lake (cf. GSC-5240, below). The peat sections reflect the Holocene migration of the treeline, and vegetation and climate changes. The basal Thibaudeau site age of 6310 years BP at 160 cm depth is virtually the same as the basal age of 6280 yr. BP at 350 cm at Bradshaw site. Both of these ages are considerably younger than minimum ages for disappearance of Glacial Lake Agassiz and maximum limit of Tyrrell Sea at about 7800 yr. The pollen profiles show that spruce trees were abundant in the region 6300 years ago and remained so to the present. Similar plant communities occurring at present also characterized the region throughout the entire time interval represented, with areas of bog and fen shifting as conditions changed locally. Areas covered by organic deposits must have increased as paludification continued over time. Except for a change to bog from fen conditions in the last several hundred years at some sites, there are no discernable trends at the sites studied. No changes in tree line, expected due to Nichols' conclusions based on sites farther north at Ennadai Lake (Nichols, 1967; Figure 1), are apparent from the profiles, even though treeline presently passes through the region. This might be because the vegetation zonation from tundra to boreal forest in this region could be controlled by their proximity to Hudson Bay and not by regional continental Arctic air mass movements, as suggested for the treeline changes farther north and inland.

BGS-980 Beaver Creek

uncorrected age: 5960 ± 100

The basal wood was overlain by 4 m of peat. Sample '84-Ch-1' was collected by E. Nielsen on June 10, 1984, from 10 km south of junction of Churchill River and Beaver Creek, Manitoba (57°40'N, 95°25'W). This sample was submitted by E. Nielsen to gain information on the initiation of peat deposition.

GSC-5240 Bradshaw Lake

normalized age: 6280 ± 90
$\delta^{13}C$= -24.4‰
uncorrected age: 6260 ± 90

The basal peat was enclosed in peat. Sample 'DU-78-193', from 350 cm depth in a forested bog, was collected by L.A. Dredge and M. Nixon on July 19, 1978, from along Bradshaw Lake, 130 km southwest of Churchill, Manitoba (57°41.8'N, 95°54.0'W), at an elevation of 215 m. This sample was submitted by L.A. Dredge to gain information on peat accumulation and climate change.

Comment (L.A. Dredge): This basal sample was from a depth of 350 cm at a site that lies within the boreal forest. The spruce forest is underlain by peat which has accumulated on the clay of Glacial Lake Agassiz. Consult GSC-5221 (above) for additional comments.

Moorby Lake Series

A series of peat samples from Moorby Lake, Manitoba (59°28'20"N, 101°12'30"W), at an elevation of about 390 m, was collected by R.N.W. DiLabio and W.B. Coker on July 15, 1978. These samples were submitted by R.N.W. DiLabio to gain information on peat diagenesis and geochemical enrichment.

GSC-2798 Moorby Lake I

normalized age: 1040 ± 50
$\delta^{13}C$= -26.9‰
uncorrected age: 1070 ± 50

The *Sphagnum* peat sample '64N 781058' from 30-41 cm depth was collected just below the permafrost table.

Chemical analyses:
2.6 ppb uranium in interstitial waters after thawing;
0.5 ppm uranium on dry weight basis;
27.4 ppm uranium on ashed weight basis.

GSC-2803 Moorby Lake Ii

normalized age: 4450 ± 60
$\delta^{13}C$= -32.7‰
uncorrected age: 4570 ± 60

The peat sample '64N781067' from 128-141 cm depth was collected 98 to 111 cm below the permafrost table.

Chemical analyses:
5.4 ppb uranium in interstitial waters after thawing;
27.0 ppm uranium on dry weight basis;
700.0 ppm uranium on ashed weight basis.

GSC-2759 Moorby Lake III

normalized age: 5990 ± 80
$\delta^{13}C$= -27.7‰
uncorrected age: 6040 ± 80

The basal humified peat sample '64N781076' from 240-254 cm depth was enclosed in peat overlying sand. The sample was collected 210 to 224 cm below the permafrost table i.e. the bottom zone of 2.5 m-thick uraniferous bog.

Chemical analyses:
200.0 ppb uranium in interstitial waters after thawing;
786.0 ppm uranium on dry weight basis;
1054.0 ppm uranium on ashed weight basis.

General comments on series (R.N.W. DiLabio): GSC-2759 provides an estimate for the onset of uranium enrichment of the peat. Based on GSC-2759 and -2803, the uranium-rich, most humified lower portion of the peat section, accumulated in a warmer episode than at present (Nichols, 1974) since peat diagenesis and uranium enrichment could proceed only when the peat was unfrozen. The geochemical results on this bog and an adjacent one are discussed in Coker and DiLabio (1979).

RADIOCARBON DATES ON MODERN LAKES[2] (Fig. 8)

Radiocarbon Dates related to Dauphin Lake

Beta-86328 Dauphin Lake I

normalized age: 2910 ± 90
$\delta^{13}C$= -4.5‰
uncorrected age: 2570 ± 80

The freshwater shells (*Sphaerium*; identified by G.E. Tackman) were enclosed in bedded sand and gravel. Sample '509-1.13' from 0.6 m depth was collected by G.E. Tackman and D. Currey in the Dauphin Lake area, Manitoba (51.103°N, 99.668°W), at an elevation of 262.9 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level Ia3, of Dauphin Lake, and postglacial rebound.

The calibrated age is 1065 BC (1250 BC - 940 BC).

The sample dates the beach crest of level Ia3.

Beta-86329 Dauphin Lake II

normalized age: 4630 ± 60
$\delta^{13}C$= -6.7‰
uncorrected age: 4340 ± 60

The freshwater shells (*Lampsilis radiata*; identified by G.E. Tackman) were a surface collection from rodent burrows in a beach crest. Sample '509-1.2' was collected by G.E. Tackman and D. Currey in the Dauphin Lake area, Manitoba (51.103°N, 99.669°W), at an elevation of 262.3 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level Id, of Dauphin Lake, and postglacial rebound.

The calibrated age is 3365 BC (3500 BC -3345 BC).

The sample dates the beach crest of level Id.

Beta-77529 Dauphin Lake III

normalized age: 2990 ± 70
$\delta^{13}C$= -5.1‰
uncorrected age: 2660 ± 70

The freshwater shells (*Sphaerium*; identified by G.E. Tackman) were a surface collection from rodent burrows in shallow surface sand on beach crest. Sample '422-1.1' was collected by G.E. Tackman and D. Currey in the Dauphin Lake area, Manitoba (51.103°N, 99.708°W), at an elevation of 262.6 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level Ia3, of Dauphin Lake, and postglacial rebound.

The calibrated age is 1215 BC (1305 BC - 1110 BC).

Beta-77530 Dauphin Lake IV

normalized age: 1040 ± 50
$\delta^{13}C$= -6.1‰
uncorrected age: 730 ± 50

The freshwater shells (*Sphaerium*; identified by G.E. Tackman) were a surface collection from rodent burrows in clean sand on beach crest. Sample '422-1.2' was collected by G.E. Tackman and D. Currey in the Dauphin Lake area, Manitoba (51.105°N, 99.709°W), at an elevation of 262.5 m. This sample was submitted by G.E. Tackman to gain information on the beach crest of Dauphin Lake, and postglacial rebound.

The calibrated age is 1005 AD (980 AD - 1025 AD).

Beta-68099 (AMS) Dauphin Lake V

normalized age: 590 ± 80
$\delta^{13}C$= -6.4‰
uncorrected age: 280 ± 80

The freshwater shells (*Sphaerium*; identified by G.E. Tackman) were enclosed in the top of a black organic marsh deposit directly overlain by 0.7 m of beach sand. Sample '19-5.1' was collected by G.E. Tackman and D. Currey in the Dauphin Lake area, Manitoba (51.109°N, 99.695°W), at an elevation of 262.7 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level LIA, of Dauphin Lake, and postglacial rebound.

The calibrated age is 1400 AD (1300 AD - 1430 AD).

This date provides a maximum, limiting age for beach crest and marks onset of transgression for this beach.

Beta-86330 (AMS) Dauphin Lake VI

normalized age: 4650 ± 50
$\delta^{13}C$= -4.0‰
uncorrected age: 4310 ± 50

The freshwater shells (*Lampsilis radiata*; identified by G.E. Tackman) were enclosed in humic sand. Sample '509-3.3' from 0.3 m depth was collected by G.E. Tackman and D. Currey from Crescent Cove near Ochre Beach on Dauphin Lake, Manitoba (51.121°N, 99.779°W), at an elevation of 261.8 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level Id, of Dauphin Lake, and postglacial rebound.

The calibrated age is 3370 BC (3505 BC - 3355 BC).

This sample dates the Crescent Cove beach crest.

[2] Please consult the 'Introduction' on page 1 for the format of data presentation, specifically the 'normalization' of AMS dates.

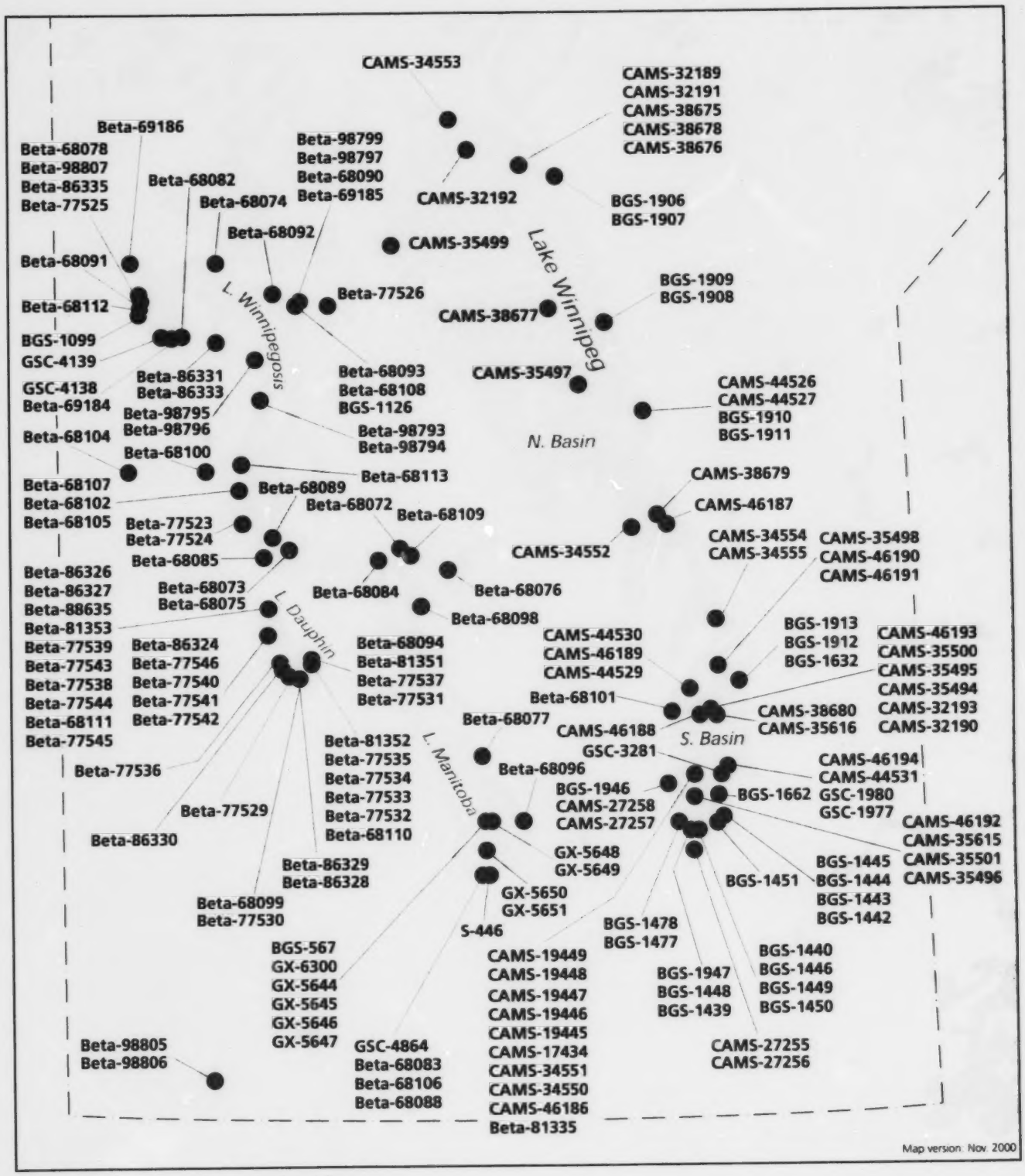

Figure 8. Radiocarbon dates on modern lakes.

Beta-77535 Dauphin Lake VII

normalized age: 7730 ± 140
$\delta^{13}C$= -4.2‰
uncorrected age: 7390 ± 130

The freshwater shells (*Sphaerium*; identified by G.E. Tackman) were a surface collection from rodent burrows in a humic pebbly sand from beach surface. Sample '424-1.6' was collected by G.E. Tackman and D. Currey near Hansen Creek, Dauphin Lake area, Manitoba (51.164°N, 99.552°W), at an elevation of 262.4 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level IV, of Dauphin Lake, and postglacial rebound.

The calibrated age is 6485 BC (6630 BC - 6415 BC).

This sample dates the beach crest of level IV.

Beta-68110 Dauphin Lake VIII

normalized age: 420 ± 100
$\delta^{13}C$= -6.7‰
uncorrected age: 120 ± 90

The freshwater shells (*Sphaerium*; identified by G.E. Tackman) were enclosed in clean fossiliferous sand, over a thin black peat and under marsh / lagoon deposits. Sample '21-1.1f' was collected by G.E. Tackman and D. Currey near Hansen Creek, Dauphin Lake area, Manitoba (51.164°N, 99.568°W), at an elevation of 261.7 m. This sample was submitted by G.E. Tackman to gain information on the shoreline, level LIA, of Dauphin Lake, and postglacial rebound.

The calibrated age is 1450 AD (1420 AD - 1530 AD).

This is a minimum age for the level LIA shoreline.

Beta-77536 Dauphin Lake IX

normalized age: 2540 ± 60
$\delta^{13}C$= -6.3‰
uncorrected age: 2240 ± 60

The freshwater shells (*Sphaerium*; identified by G.E. Tackman) were a surface collection from rodent burrows in a light coloured pebbly sand on beach. Sample '425-1.6' was collected by G.E. Tackman and D. Currey from Dauphin Beach, Dauphin Lake, Manitoba (51.164°N, 99.861°W), at an elevation of 261.9 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level Ia2, Dauphin Lake, and postglacial rebound.

The calibrated age is 780 BC (795 BC - 540 BC).

This date provides a maximum age for level Ia2.

Beta-77532 Dauphin Lake X

normalized age: 4320 ± 130
$\delta^{13}C$= -3.6‰
uncorrected age: 3970 ± 130

The freshwater shells (*Sphaerium*; identified by G.E. Tackman) were a surface collection from rodent burrows in humic, pebbly sand at beach surface. Sample '401-1.5' was collected by G.E. Tackman and D. Currey in the Dauphin Lake area, Manitoba (51.170°N, 99.560°W), at an elevation of 263.1 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level Ib, of Dauphin Lake, and postglacial rebound.

The calibrated age is 2910 BC (3085 BC - 2770 BC).

This sample dates the beach crest of level Ib.

Dauphin Lake Series

A series of freshwater shell samples from Dauphin Lake area, Manitoba (51.171°N, 99.556°W), at an elevation of 263.9 m, was collected by G.E. Tackman and D. Currey. These samples were submitted by G.E. Tackman to gain information on the beach crest, level Id, of Dauphin Lake, and postglacial rebound.

Beta-77533 Dauphin Lake XI

normalized age: 4530 ± 60
$\delta^{13}C$= -3.1‰
uncorrected age: 4180 ± 60

The freshwater shells (*Sphaerium*; identified by G.E. Tackman) of sample '401-1.6' were enclosed in 1 m fine white sand, under 1 m of beach gravel with *Lampsilis radiata* fragments.

The calibrated age is 3325 BC (3350 BC - 3095 BC).

The date provides a maximum age for level Id.

Beta-77534 Dauphin Lake XII

normalized age: 4540 ± 70
$\delta^{13}C$= -5.0‰
uncorrected age: 4210 ± 70

The freshwater shells (*Lampsilis radiata*; identified by G.E. Tackman) of sample '424ldf' were enclosed in the upper 1 m of beach-crest gravelly sand overlying 1 m of fine white sand.

The calibrated age is 3335 BC (3360 BC - 3095 BC).

The date provides a maximum age for level Id.

Beta-81352 Dauphin Lake XIII

normalized age: 6330 ± 170
$\delta^{13}C$= -4.7‰
uncorrected age: 5990 ± 160

The freshwater shells (*Sphaerium*; identified by G.E. Tackman) were a surface collection in clean white sand from rodent burrows on the foreshore beach. Sample '401-1.7' was collected by G.E. Tackman and D. Currey in the Dauphin Lake area, Manitoba (51.172°N, 99.551°W), at an elevation of 262.2 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level III, of Dauphin Lake, and postglacial rebound.

The calibrated age is 5265 BC (5435 BC - 5065 BC).

Beta-77531 Dauphin Lake XIV

normalized age: 6200 ± 120
$\delta^{13}C$= -2.8‰
uncorrected age: 5840 ± 110

The freshwater shells (*Sphaerium*; identified by G.E. Tackman) were enclosed in fine white sand overlying 2 m of gravelly sand with *Lampsilis radiata* fragments. Sample '424-3.19p' from 2 m depth (below crest) was collected by G.E. Tackman and D. Currey in the Dauphin Lake area, Manitoba (51.185°N, 99.550°W), at an elevation of 262.4 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level III, of Dauphin Lake, and postglacial rebound.

The calibrated age is 5150 BC (5260 BC - 4955 BC).

This date provides a maximum age for level III.

Beta-77537 Dauphin Lake XV

normalized age:	6120 ± 90
	$\delta^{13}C$= -3.3‰
uncorrected age:	5770 ± 90

The freshwater shells (*Sphaerium*; identified by G.E. Tackman) were enclosed in red sand under granules and stratified sand and gravel over marsh deposit and grey sand. A sample was collected by G.E. Tackman and D. Currey in the Dauphin Lake area, Manitoba (51.189°N, 99.553°W), at an elevation of 259.3 m. The shells were submitted by G.E. Tackman to gain information on the shoreline, level III, of Dauphin Lake, and postglacial rebound.

The calibrated age is 5040 BC (5210 BC - 4925 BC).

The sample was collected in small core at a depth of 4.1 m (13.5 ft) below beach crest in clean red (ground-water oxidized) sand underlain by a 2-inch marsh deposit which in turn is underlain by fine grey sand. It was below a bed of granules overlain by stratified sand and gravel. This is a minimum elevation for lake level.

Beta-81351 Dauphin Lake XVI

normalized age:	4630 ± 80
	$\delta^{13}C$= -4.1‰
uncorrected age:	4290 ± 70

The freshwater shell fragments (unidentified gastropod) were enclosed in clean foreshore sand and gravel. A sample from a depth of about 1.5 m below crest was collected by G.E. Tackman and D. Currey in the Dauphin Lake area, Manitoba (51.189°N, 99.555°W), at an elevation of 263.7 m. This sample was submitted by G.E. Tackman to gain information on the shoreline, level Id, of Dauphin Lake, and postglacial rebound.

The calibrated age is 3365 BC (3510 BC - 3340 BC).

Comment (G.E. Tackman): These shell fragments were from high spiral gastropods. All were less than 2 cm in length with 5.5 whorls. The date provides a maximum age for level Id and is a minimum elevation for lake level.

Beta-68094 (AMS) Dauphin Lake XVII

normalized age:	1950 ± 60
	$\delta^{13}C$= -8.7‰
uncorrected age:	1680 ± 60

The freshwater shells (*Stagnicola*; identified by G.E. Tackman) were enclosed in the top of a lagoon deposit, directly underlying 1.6 m stratified gravel and sand. Sample '19-6.1' was collected by G.E. Tackman and D. Currey near East Bay, Dauphin Lake, Manitoba (51.200°N, 99.567°W), at an elevation of 263.2 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, and postglacial rebound.

The calibrated age is 100 AD (0 AD - 130 AD).

This date provides a maximum, limiting age for the beach crest and also marks the onset of transgression for this beach.

Beta-86324 Dauphin Lake XIX

normalized age:	3720 ± 60
	$\delta^{13}C$= -4.7‰
uncorrected age:	3380 ± 60

The freshwater shells (*Sphaerium*; identified by G.E. Tackman) were a surface collection from rodent burrows in the beach crest. Sample '507-1.6' was collected by G.E. Tackman and D. Currey in the Valley River area, north of Dauphin Lake, Manitoba (51.325°N, 99.921°W), at an elevation of 261.0 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level Iab, of Dauphin Lake, and postglacial rebound.

The calibrated age is 2093 BC (2190 BC - 2015 BC).

This sample dates the beach crest of level Iab.

Beta-77546 Dauphin Lake XX

normalized age:	4740 ± 60
	$\delta^{13}C$= -4.0‰
uncorrected age:	4400 ± 60

The freshwater shells (*Lampsilis radiata*; identified by G.E. Tackman) were a surface collection from rodent burrows in the beach surface. Sample '507-1.11' was collected by G.E. Tackman and D. Currey in the Valley River area, north of Dauphin Lake, Manitoba (51.327°N, 99.923°W), at an elevation of 262.8 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level Id, of Dauphin Lake, and postglacial rebound.

The calibrated age is 3520 BC (3630 BC - 3380 BC).

The sample dates the beach crest of level Id.

Beta-77540 Dauphin Lake XXI

normalized age:	2870 ± 60
	$\delta^{13}C$= -7.9‰
uncorrected age:	2590 ± 60

The freshwater shells (*Sphaerium*; identified by G.E. Tackman) were enclosed in clean, coarse sand in the upper 1 m of the beach crest. Sample '428-1.8' was collected by G.E. Tackman and D. Currey in the Valley River area, north of Dauphin Lake, Manitoba (51.342°N, 99.930°W), at an elevation of 262.1 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level Ia3, of Dauphin Lake, and postglacial rebound.

The calibrated age is 1015 BC (1120 BC - 930 BC).

This date provides a maximum age for level Ia3.

Beta-77541 (AMS) Dauphin Lake XXII

normalized age: 2280 ± 50
$\delta^{13}C$= -8.4‰
uncorrected age: 2010 ± 50

The freshwater shells (*Sphaerium*; identified by G.E. Tackman) were enclosed in coarse beach sand. Sample '428-1.11' from 0.5 m depth was collected by G.E. Tackman and D. Currey in the Valley River area, north of Dauphin Lake, Manitoba (51.344°N, 99.927°W), at an elevation of 261.6 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level Ia1, of Dauphin Lake, and postglacial rebound.

The calibrated age is 375 BC (390 BC - 230 BC).

The date provides a maximum age for level Ia1.

Beta-77542 Dauphin Lake XXIII

normalized age: 3450 ± 80
$\delta^{13}C$= -4.7‰
uncorrected age: 3120 ± 80

The freshwater shells (*Sphaerium*; identified by G.E. Tackman) were enclosed in the upper 1 m of clean, loose, coarse beach crest sand. Sample '428-2.1' was collected by G.E. Tackman and D. Currey in the Valley River area, north of Dauphin Lake, Manitoba (51.346°N, 99.945°W), at an elevation of 263.1 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level Iab, of Dauphin Lake, and postglacial rebound.

The calibrated age is 1745 BC (1880 BC - 1660 BC).

The date provides a maximum age for level Iab.

Beta-86326 Dauphin Lake XXIII

normalized age: 7800 ± 110
$\delta^{13}C$= -3.9‰
uncorrected age: 7450 ± 100

The freshwater shells (*Sphaerium*; identified by G.E. Tackman) were a surface collection from rodent burrows in the beach crest. Sample '508-2.1' was collected by G.E. Tackman and D. Currey from Oak Brae, southern Lake Winnipegosis, Manitoba (51.442°N, 99.863°W), at an elevation of 264.1 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level IV, of Dauphin Lake, and postglacial rebound.

The calibrated age is 6580 BC (6690 BC - 6465 BC).

The sample dates the beach crest of level IV.

Beta-86327 Dauphin Lake XXIV

normalized age: 3120 ± 70
$\delta^{13}C$= -4.1‰
uncorrected age: 2770 ± 70

The freshwater shells (*Sphaerium*; identified by G.E. Tackman) were a surface collection from rodent burrows in the beach crest. Sample '508-2.8' was collected by G.E. Tackman and D. Currey from Oak Brae, southern Lake Winnipegosis, Manitoba (51.442°N, 99.864°W), at an elevation of 263.1 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level Ia3, of Dauphin Lake, and postglacial rebound.

The calibrated age is 1400 BC (1435 BC - 1295 BC).

The sample dates the beach crest of level Ia3.

Beta-88635 Dauphin Lake XXV

normalized age: 2780 ± 80
$\delta^{13}C$= -4.0‰
uncorrected age: 2430 ± 80

The freshwater shells (*Sphaerium*; identified by G.E. Tackman) were a surface collection. Sample '508-3f' was collected by G.E. Tackman and D. Currey from Oak Brae, southern Lake Winnipegosis, Manitoba (51.446°N, 99.868°W), at an elevation of 264.0 m. This sample was submitted by G.E. Tackman to gain information on the shoreline, level Ia3, of Dauphin Lake, and postglacial rebound.

The calibrated age is 910 BC (1005 BC - 825 BC).

This is a minimum elevation for lake level and dates the Ia3 platform below level IV.

Oak Brae Series

A series of freshwater shell samples from Oak Brae, southern Lake Winnipegosis, Manitoba (51.451°N, 99.871°W), at an elevation of 263.9 m, was collected by G.E. Tackman and D. Currey. These samples were submitted by G.E. Tackman to gain information on the shoreline, level Id, of Dauphin Lake, and postglacial rebound.

Beta-81353 Dauphin Lake XXVI

normalized age: 4980 ± 120
$\delta^{13}C$= -4.4‰
uncorrected age: 4650 ± 120

The freshwater shell fragments (unidentified gastropod) of sample '427-1.7f' were a surface collection from rodent burrows.

The calibrated age is 3770 BC (3945 BC - 3650 BC).

Comment (G.E. Tackman): These shell fragments were high spiral gastropods; all less than 2 cm in length with 5.5 whorls. This is a minimum elevation for lake level. The base of shoreline III at Oak Brae, shows that level Id is accreting on III.

Beta-77539 Dauphin Lake XXVII

normalized age: 6100 ± 130
$\delta^{13}C$= -3.0‰
uncorrected age: 5740 ± 130

The freshwater shells (*Sphaerium*; identified by G.E. Tackman) of sample '427-1.7' were a surface collection from rodent burrows at the beach surface.

The calibrated age is 4985 BC (5220 BC - 4840 BC).

This sample dates the beach crest.

Beta-77543 (AMS) Dauphin Lake XXVIII

normalized age: 6540 ± 60
$\delta^{13}C$= -3.3‰
uncorrected age: 6180 ± 60

The freshwater shells (*Sphaerium*; identified by G.E. Tackman) were enclosed in silty sand. Sample '429-1.2' was collected by G.E. Tackman and D. Currey near Oak Brae, southern Lake Winnipegosis, Manitoba (51.452°N, 99.921°W), at an elevation of 264.0 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level III, of Dauphin Lake, and postglacial rebound.

The calibrated age is 5445 BC (5480 BC - 5425 BC).

The sample from a small excavation in the beach crest dates the beach crest of level III.

Beta-77538 Dauphin Lake XXIX

normalized age: 400 ± 60
$\delta^{13}C$= -7.4‰
uncorrected age: 110 ± 60

The freshwater shells (*Lampsilis radiata*; identified by G.E. Tackman) were enclosed in a 4 cm-thick bed of sandy gravel within stratified beach sand and gravel. Sample '427-1.4' was collected by G.E. Tackman and D. Currey near Oak Brae, southern Lake Winnipegosis, Manitoba (51.453°N, 99.883°W), at an elevation of 262.7 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level LIA, of Dauphin Lake, and postglacial rebound.

The calibrated age is 1470 AD (1440 AD - 1630 AD).

The date provides a maximum age for level LIA.

Beta-77544 Dauphin Lake XXX

normalized age: 300 ± 60
$\delta^{13}C$= -6.2‰
uncorrected age: modern

The freshwater shells (*Sphaerium*; identified by G.E. Tackman) were a surface collection from rodent burrows on the beach surface. Sample '429-3.2' was collected by G.E. Tackman and D. Currey near Oak Brae, southern Lake Winnipegosis, Manitoba (51.455°N, 99.906°W), at an elevation of 262.0 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level LIA, of Dauphin Lake, and postglacial rebound.

The calibrated age is 1640 AD (1505 AD - 1660 AD).

This sample dates the beach crest of level LIA.

Beta-68111 (AMS) Dauphin Lake XXXI

normalized age: 3310 ± 60
$\delta^{13}C$= -4.6‰
uncorrected age: 2980 ± 60

The freshwater shells (*Sphaerium*; identified by G.E. Tackman) were enclosed in sand. Sample '20-9.1' (0.56 m depth) was collected by G.E. Tackman and D. Currey near Oak Brae, southern Lake Winnipegosis, Manitoba (51.456°N, 99.901°W), at an elevation of 263.0 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level Ia3, of Dauphin Lake, and postglacial rebound.

The calibrated age is 1555 BC (1655 BC - 1510 BC).

The date provides a maximum, limiting age for the beach crest.

Beta-77545 (AMS) Dauphin Lake XXXII

normalized age: 7970 ± 60
$\delta^{13}C$= -4.3‰
uncorrected age: 7630 ± 60

The freshwater shells (*Sphaerium*; identified by G.E. Tackman) were a surface collection from rodent burrows in silty pebbly sand on the beach surface. Sample '429-4.6' was collected by G.E. Tackman and D. Currey near Oak Brae, southern Lake Winnipegosis, Manitoba (51.458°N, 99.892°W), at an elevation of 263.9 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level IV, of Dauphin Lake, and postglacial rebound.

The calibrated age is 6878 BC (7010 BC - 6690 BC).

The sample dates the beach crest of level IV.

Comment (G.E. Tackman): For comments and interpretation of the dates submitted by G.E. Tackman refer to Tackman, G.E., 1997, and Tackman et al., 1998. Additional field assistance to G.E. Tackman and D. Currey was provided by D. Roberts, T. Wambeam, M. Finco and G. Atwood during the project. Financial support for Tackman's Ph.D. research was provided by NASA (Grant Number NAG 5-2055) with additional support from GSA (5718-95) and is gratefully acknowledged.

Radiocarbon Dates related to Lake Manitoba

Lake Manitoba Series I

A series of freshwater shell samples near Lake Manitoba, south central Manitoba (50.184°N, 98.368°W), at elevations of about 813 m and 247.8 m, was collected by G.E. Tackman and D. Currey. These samples were submitted by G.E. Tackman to gain information on the lake level change of Lake Manitoba, and postglacial rebound.

Beta-68083 Lake Manitoba

normalized age: 460 ± 90
$\delta^{13}C$= -1.9‰
uncorrected age: 80 ± 80

The freshwater shells (*Sphaerium*; identified by G.E. Tackman), sample '13-2f', were enclosed in medium to coarse sand with abundant shells, under and over marsh / lagoon organic beds.

Note: the elevation of 813 m was taken from topo sheet and is therefore approximate.

The calibrated age is 1440 AD (1405 AD -1485 AD).

Beta-68106 Lake Manitoba

normalized age: 480 ± 70
$\delta^{13}C$= -8.8‰
uncorrected age: 210 ± 70

The freshwater shells (*Stagnicola*; identified by G.E. Tackman) in the upper 20 cm, at an elevation of 247.8 m, were enclosed in a peat bed and overlain by sand just above the modern lake-level of Lake Manitoba.

The calibrated age is 1435 AD (1405 AD - 1470 AD).

Beta-68088 Lake Manitoba

normalized age: 270 ± 50
$\delta^{13}C$= -27.3‰
uncorrected age: 310 ± 50

The peat sample '13-3f', at an elevation of 247.8 m, was enclosed in peat and overlain by medium coarse sand bed with reworked organics.

The calibrated age is 1650 AD (1530 AD - 1665 AD).

S-446 Barrier Island

uncorrected age: 2400 ± 230

The organic material overlies clayey silt to silty clay (200-300 cm) and clay-sand to clay-silt (300-305 cm). The sample from 102-106 cm depth was collected by T.A. Sproule in 1968, from the south side of Barrier Island, Cadham Bay at south edge of the village of Delta, 22 km north of Portage la Prairie, Manitoba (50°11'13"N, 98°17'52"W), at an elevation of 246 m. This sample was submitted by T.A. Sproule to gain information on lake level change in Lake Manitoba.

Comment (T.A. Sproule): This date is near the base of a pollen and macrofossil zone indicating nearly continuous marsh conditions at the site from 2.4 ka until the present time. Prior to this, the water was deeper.

GSC-4864 Portage diversion

normalized age: 190 ± 50
$\delta^{13}C$= -27.7‰
uncorrected age: 240 ± 50

The organic muck and fibrous plants (peat) were enclosed in clay. Sample EN-89-1 was collected by E. Nielsen on May 5, 1989, from the mouth of the Portage diversion on Lake Manitoba, 25 km north of Portage la Prairie, Manitoba (50°11'15"N, 98°22'40"W), at an elevation of 248 m. This sample was submitted by E. Nielsen to gain information on lake level change in Lake Manitoba, and the barrier beach transgression.

Comment (E. Nielsen): The dated sample consisted of organic muck and fibrous plants, associated with muskrat and frog bones and is interpreted as having been deposited in a marsh environment. The exposure on the high energy foreshore of Lake Manitoba suggests that the barrier beach has transgressed an estimated 60 m in the last 200 years.

Lake Manitoba Series II

A series of organic lake sediment samples in 'core III' from 35 km north of Portage la Prairie, Lake Manitoba, Manitoba (50°17'29"N, 98°18'50"W), at an elevation of about 250 m, was collected by W. Last in 1978. These samples were submitted by W. Last to gain information on the lake level change in Lake Manitoba.

GX-5650 Lake Manitoba

uncorrected age: 8770 ± 220

The organic lake sediment sample from a 9.6 m Shelby tube core was enclosed in clayey silt. The upper 9.2 m of this core are composed of clayey silt, silt, and sandy clayey silt and overlies till.

Comment (W. Last): This date is interpreted as being contaminated by pre- Quaternary organic carbon and is too old by about 800 years (cf. Nambudiri, et al., 1980). This sample and GX-5651 are from a core that is coarser grained than those farther to the north, i.e. farther from the previous mouth of the Assiniboine River.

GX-5651 Lake Manitoba

uncorrected age: 10 150 ± 270

The basal organic lake sediment sample from 874-884 cm depth was enclosed in clayey silt which underlay clayey silt, and sandy clayey silt.

Comment (W. Last): This date is interpreted as being contaminated by pre-Quaternary organic carbon and is too old by about 200 years (cf. Nambudiri, et al., 1980).

Lake Manitoba Series III

A series of organic lake sediment samples from 44 km north of Portage la Prairie, Lake Manitoba, Manitoba (50°28'01"N, 98°13'31"W), at an elevation of about 250 m, was collected by W. Last in 1978. These samples were submitted by W. Last to gain information on climate change, and water table fluctuation.

GX-5648 Lake Manitoba

uncorrected age: 6240 ± 180

The organic lake sediment sample from a 10.7 m Shelby tube core was enclosed in silty clay. The entire 10.7 m core was predominantly clayey silt to silty clay with scattered ice-rafted clasts below 10.3 m. The sediment dated is about one-half metre below the top of the youngest 'dry' zone in Lake Manitoba.

Comment (W. Last): These dates bracket the youngest 'dry' zone in Lake Manitoba between 4.5 ka (GX-5645) and about 6.2 ka BP.

GX-5649 Lake Manitoba

uncorrected age: 11 075 ± 350

The organic lake sediment sample from a 10.7 m Shelby tube core was enclosed in silty clay. The entire 10.7 m core was predominantly clayey silt to silty clay with scattered ice-rafted clasts below 10.3 m. The dated sediment immediately overlies the second youngest 'dry' zone in Lake Manitoba.

Comment (W. Last): This date is interpreted as being contaminated by pre- Quaternary organic carbon and is too old by about 2300 years (cf. Nambudiri, et al., 1980).

Lake Manitoba Series IV

A series of lake sediment samples from 54 km north of Portage la Prairie, Lake Manitoba, Manitoba (50°28'23"N, 98°16'10"W), at an elevation of about 250 m, was collected by J.T. Teller in 1974, and by J.T. Teller and W. Last in 1978. These samples were submitted by J.T. Teller to gain information on the lake level change in Lake Manitoba, and water table fluctuations related to climate change.

Comment (J. Teller): The entire 13.6 m of this core is predominantly clayey silt to silty clay with scattered ice-rafted clasts below 10.3 m.

GX-5644 Lake Manitoba

uncorrected age: 2555 ± 130

The lake sediment, silty clay sample from a 13.6 m Shelby tube core was enclosed in silty clay.

GX-5647 Lake Manitoba

uncorrected age: >37 000

The organic lake sediment sample from a 13.6 m Shelby tube core was enclosed in clay. The enclosing clay scattered with ice-rafted pebbles and silt clasts underlies clayey silt to silty clay except for presence of clasts and pebbles below 10.3 m.

Comment (J. Teller): This date is interpreted as being contaminated by a large proportion of pre- Quaternary organic carbon and is too old by about 25 000 years (Nambudiri, et.al. 1980). This sample is probably from the oldest Lake Agassiz sediments of the Lake Manitoba basin.

GX-5645 Lake Manitoba

uncorrected age: 4465 ± 165

The organic lake sediment sample from 320-327 cm depth in a 13.6m Shelby tube core was enclosed in silty clay.

Comment (J. Teller): This sample dates the sediment immediately overlying the youngest period of 'drying' in the lake.

BGS-567 Lake Manitoba

uncorrected age: 9500 ± 500

The finely disseminated organic material from 560-580 cm depth was enclosed in silty clay.

Comment (J.T. Teller): This date is interpreted as being contaminated by pre- Quaternary organic carbon and is too old by about 2500 years (Nambudiri, et al., 1980).

GX-5646 Lake Manitoba

uncorrected age: 10 170 ± 225

The organic lake sediment sample from 716-722 cm in a 13.6 m Shelby tube core was enclosed in silty clay.

Comment (J. Teller): This date is interpreted as being contaminated by pre- Quaternary organic carbon and is too old by about 2200 years (Nambudiri, et al., 1980).

GX-6300 Lake Manitoba

uncorrected age: 29 300 +2780 -2660

The organic lake sediment sample from a 13.6 m Shelby tube core was enclosed in silty clay.

Comment (W. Last): This date is interpreted as being contaminated by a large percentage of pre- Quaternary organic carbon and is too old by about 18 ka (cf. Nambudiri, et al. 1980).

Beta-68096 Lake Manitoba

normalized age: 2700 ± 50
$\delta^{13}C$= -7.2‰
uncorrected age: 2410 ± 50

The freshwater shells (*Stagnicola*; identified by G.E. Tackman) were enclosed in beach gravel near the crest. Sample 7-1.9p was collected by G.E. Tackman and D. Currey near Lake Manitoba, south central Manitoba (50.484°N, 98.013°W), at an elevation of 249.0 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, lake level change in Lake Manitoba, and postglacial rebound.

The calibrated age is 830 BC (890 BC - 810 BC).

Beta-68077 Lake Manitoba

normalized age: 740 ± 60
$\delta^{13}C$= -2.9‰
uncorrected age: 380 ± 60

The freshwater shells (*Lampsilis radiata*; identified by G.E. Tackman) were a surface collection on a variably thick organic bed just below beach crest. Sample 8-1.5p was collected by G.E. Tackman and D. Currey near Lake Manitoba, south central Manitoba (50.727°N, 98.277°W), at an elevation of 249.6 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, lake level change, and postglacial rebound.

The calibrated age is 1285 AD (1255 AD - 1300 AD).

Beta-68098 Lake Manitoba

normalized age: 7330 ± 60
$\delta^{13}C$= -4.4‰
uncorrected age: 6990 ± 60

The freshwater shells (*Probythinella emarginata*; revised by J-M. Gagnon) were a surface collection from rodent burrows in the foreshore of a beach. Sample 23-8f was collected by G.E. Tackman and D. Currey near Lake Manitoba, south central Manitoba (51.459°N, 98.766°W), at an elevation of 250.2 m. This sample was submitted by G.E. Tackman to gain information on the shoreline of Lake Manitoba, and postglacial rebound.

The calibrated age is 6170 BC (6190 BC - 6055 BC).

Beta-68076 Lake Manitoba

normalized age: 5210 ± 100
$\delta^{13}C$= -3.5‰
uncorrected age: 4860 ± 100

The freshwater shells (*Lampsilis radiata*; identified by G.E. Tackman) were enclosed in the top of a black organic (marsh/lagoon) bed under 1.2 m of beach gravel. Sample 23-3.1 was collected by G.E. Tackman and D. Currey near Lake Manitoba, south central Manitoba (51.644°N, 98.546°W), at an elevation of 250.0 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, the onset of transgression, and postglacial rebound.

The calibrated age is 3990 BC (4220 BC - 3950 BC).

Beta-68109 Lake Manitoba

normalized age: 1340 ± 90
$\delta^{13}C$= -1.5‰
uncorrected age: 960 ± 90

The freshwater shells (*Stagnicola*; identified by G.E. Tackman) were enclosed in beach sediments. Sample 23-8.2 was collected by G.E. Tackman and D. Currey from a roadcut through a beach, near Lake Manitoba, south central Manitoba (51.722°N, 98.771°W), at an elevation of 249.8 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, and postglacial rebound in the Lake Manitoba basin.

The calibrated age is 675 AD (645 AD - 780 AD).

Beta-68084 Lake Manitoba

normalized age: 500 ± 60
$\delta^{13}C$= -1.3‰
uncorrected age: 110 ± 60

The freshwater shells (*Stagnicola*; identified by G.E. Tackman) were enclosed in the top of 0.46 m of beach sand. Sample 24-1.1 was collected by G.E. Tackman and D. Currey near Lake Manitoba, south central Manitoba (51.722°N, 99.077°W), at an elevation of 248.8 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, and postglacial rebound.

The calibrated age is 1430 AD (1405 AD - 1445 AD).

Beta-68072 Lake Manitoba

normalized age: 400 ± 70
$\delta^{13}C$= -5.7‰
uncorrected age: 80 ± 70

The freshwater shells (*Lampsilis radiata*; identified by G.E. Tackman) were a surface collection from rodent burrows in a beach crest. Sample 22-3.1 was collected by G.E. Tackman and D. Currey near Lake Manitoba, south central Manitoba (51.744°N, 98.863°W), at an elevation of 248.6 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, and postglacial rebound.

The calibrated age is 1470 AD (1440 AD - 1560 AD).

General comment (G.E. Tackman): For comments and interpretation of the dates submitted by G.E. Tackman please refer to Tackman, G.E., 1997, and Tackman, et al., 1998. Additional field assistance to G.E. Tackman and D. Currey was provided by D. Roberts, T. Wambeam, M. Finco and G. Atwood during the project. Financial support for Tackman's Ph.D. research was provided by NASA (Grant Number NAG 5-2055) with additional support from GSA (5718-95) and is gratefully acknowledged.

Radiocarbon Dates related to Lake Winnipeg

The 'South Basin'

CAMS-27255 Netley Marsh I

normalized age: 450 ± 70

The bulrush seeds (*Scirpus* cf. *acutus*; identified by R.E. Vance) were enclosed in the base of an organic silt (0-114 cm) overlying Lake Agassiz clay. Core 'NB-96-3' was collected by E. Nielsen on March 13, 1996, from Netley Marsh on Netley Lake, Manitoba (50°18.22'N, 96°52.57'W), at an elevation of about 217.4 m. This sample was submitted by E. Nielsen to gain information on the shorezone of Lake Winnipeg, and the initiation of Netley Marsh sedimentation.

The age was normalized assuming a $\delta^{13}C$= -25‰.

Stratigraphy: An auger sample (2.16 m) was obtained in 1.0 m of water. The dated bulrush seeds were from the base of organic silt (114 cm) overlying Lake Agassiz clay at an elevation of 215.2 m asl.

Comments (A.M. Telka and E. Nielsen): The preservational state of the dated bulrush seeds was excellent with bristles and distal tips attached. The date of 0.45 ka provides a minimum age for the beginning of Netley Marsh sedimentation.

CAMS-27256 Netley Marsh II

normalized age: 650 ± 60

The prairie bulrush seed (*Scirpus* cf. *paludosus*; identified by R.E. Vance) was enclosed in the base of a firm brown organic-rich clay (0-190 cm) overlying Lake Agassiz clay. Core 'NB-96-1' was collected by E. Nielsen on March 13, 1996, from Netley Marsh on Netley Lake, Manitoba (50°18.98'N, 96°51.62'W), at an elevation of about 217.4 m. This sample was submitted by E. Nielsen to gain information on the shorezone of Lake Winnipeg, and the initiation of Netley Marsh sedimentation.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: An auger sample (3.1 m) obtained in 1.3 m of water. The dated bulrush seed was from the base of firm brown organic-rich clay (190 cm) overlying Lake Agassiz clay at an elevation of 214.2 m asl.

Comments (A.M. Telka and E. Nielsen): The preservational state of the dated bulrush seed was excellent with bristles and distal tip attached. The date of 0.65 ka provides a minimum age estimate for the beginning of Netley Marsh sedimentation.

BGS-1446 Pruden Creek

uncorrected age: 230 ± 70

The wood was a surface collection on beach sand. Sample NB-90-69-9 was collected by E. Nielsen on July 13, 1990, from Pruden Creek on the southern shore of the south basin of Lake Winnipeg,

Manitoba (50°23'25"N, 96°45'10"W), at an elevation of about 220 m. This sample was submitted by E. Nielsen to gain information on lake level change, and Lake Winnipeg transgression.

Comment (E. Nielsen): The driftwood that was washed up on the beach was heavy and rust-stained. The wood was curled like an umbrella. There was lots of old looking wood on this part of the shore. The date indicates the age of submerged forests in the offshore.

Red River delta Series

A series of wood samples from Red River delta at the south end of the south basin of Lake Winnipeg, Manitoba (50°23'25"N, 96°46'25"W), at an elevation of 217.3 m, was collected by E. Nielsen on June 29, 1990. These samples were submitted by E. Nielsen to gain information on lake level change, and the rate of transgression in Lake Winnipeg.

BGS-1440 Red River delta I

uncorrected age: 290 ± 70

The wood sample (NB-90-69-4(i); *Salix*; identified by E. Nielsen) was enclosed in sand rich in Paleozoic carbonates.

Comment (E. Nielsen): Trees originally grew in a marsh around a lagoon on shore side of beach, and were subsequently transgressed by the beach and dune complex due to an increasing water level. The stumps are perpetually wet. This date will help to determine the rate of transgression of Lake Winnipeg.

BGS-1449 Red River delta II

uncorrected age: modern

The peat sample (NB-90-69-4(p)), a surface collection on the foreshore of beach, was deposited in a lagoon behind a barrier island that has moved south. This peat enclosed the wood sample (NB-90-69-4(w); cf. BGS-1450).

Comment (E. Nielsen): The peat was outcropping on the foreshore, but was originally deposited in lagoon behind the barrier island. This peat enclosing log-sample 'NB-90-69-4(w)' provides a comparison of the relative ages of peat and wood at the same site.

BGS-1450 Red River delta III

uncorrected age: 210 ± 70

The wood sample (NB-90-69-4(w)), enclosed in peat, was an underwater *in situ* stump.

Comment (E. Nielsen): The stump was rooted in peat on the foreshore. It was underwater most of the time. The tree originally grew in a marsh behind the barrier island. There may have been algae on the surface so the wood was scrubbed with a stiff brush prior to dating. The date provides an estimate of the rate of transgression in Lake Winnipeg, i.e. about 300 years.

Red River delta Series II

A series of wood samples from Red River delta at the south end of the south basin of Lake Winnipeg, Manitoba (50°24'10"N, 96°51'55"W), at an elevation of 217.2 m, was collected by E. Nielsen on June 25, 1990. This sample was submitted by E. Nielsen to gain information on the rate of transgression in Lake Winnipeg.

BGS-1439 Red River delta IV

uncorrected age: 335 ± 65

The wood sample (NB-90-69-2(a); *Salix*; identified by E. Nielsen), enclosed in silty clay, was an *in situ* upright stump.

BGS-1448 Red River delta V

uncorrected age: 230 ± 70

The wood sample (NB-90-69-2(c)), enclosed in silty clay, was an *in situ* stump on the foreshore of beach.

Comment (E. Nielsen): The log, rooted in silty clay on the foreshore, was waterlogged and perpetually wet. The trees originally grew in a marsh in the lagoon behind i.e. south of the barrier island, but are now found about 17 m out in Lake Winnipeg.

BGS-1947 Salamonia Channel

uncorrected age: 545 ± 80

The freshwater shells (*Lampsilis radiata siliquoidea* (Barnes); identified by E. Nielsen) were a surface collection on calcareous sand on top of 2 m-high beach ridge. Sample NB-90-69-6(j) was collected by E. Nielsen on July 9, 1990, from about 1 km west of the mouth of Salamonia Channel, on the south shore of the south basin of Lake Winnipeg, Manitoba (50°24'30"N, 96°54'00"W), at an elevation of about 220 m. This sample was submitted by E. Nielsen to gain information on the beach ridge, and lake level change in Lake Winnipeg.

Comment (E. Nielsen): The sample dates the high water stand of Lake Winnipeg or possibly a storm surge in 1966. If a 'hardwater' correction is applied to this date then the sample is modern (cf. BGS-1946).

BGS-1451 Stoney Point

normalized age: modern

The wood was enclosed in beach gravel. Sample NB-90-69-19(b) was collected by E. Nielsen on August 1, 1990, from Stoney Point, near Patricia Beach at the southeastern end of the south basin of Lake Winnipeg, Manitoba (50°25'30"N, 96°37'45"W), at an elevation of about 219 m. This sample was submitted by E. Nielsen to gain information on the beach, and storm surges on Lake Winnipeg.

Comment (E. Nielsen): Raised gravel beach was about 1.5 m above present level of Lake Winnipeg. The wood was sticking out of gravel on the surface. The buried part of the log was covered with a thin black incrustation. The wood was deposited during higher level of Lake Winnipeg, possibly a storm surge.

Sans Souci Beach Series

A series of organic-rich clay samples from the foreshore of Sans Souci Beach, on the southwestern shore of the south basin of Lake

Winnipeg, Manitoba (50°25'30"N, 96°56'25"W), at an elevation of 216.9 m, was collected by E. Nielsen on October 10, 1990. These samples were submitted by E. Nielsen to gain information on lake level change in Lake Winnipeg, and climate change (Hypsithermal).

BGS-1477 Sans Souci Beach I

uncorrected age: 3600 ± 80

The organic-rich clay sample (NB 90-69-20(a)) was a surface collection on Lake Agassiz clay. This organic-rich sediment was extracted from desiccation cracks (sub-aerial) and may be windblown topsoil. The enclosing sediment contains reworked Paleozoic carbonate.

Comment (E. Nielsen): The collection site was on the foreshore of Lake Winnipeg exposed during low water level. The sample was taken from the wet surface. There was no plant growth on this slowly eroding shore. Black organic-rich clay was removed from desiccation cracks in Lake Agassiz sediment. The dated soil is from infilled desiccation cracks of polygons 16 to 30 cm in diameter, from top of Lake Agassiz sediment, directly below Lake Agassiz Unconformity. These desiccation cracks are believed to have formed during periods of drought when the Lake Agassiz clay surface was sub-aerially exposed, and were subsequently infilled by wind blown topsoil. The date also provides a maximum age for Lake Winnipeg transgression.

BGS-1478 Sans Souci Beach II

uncorrected age: 1200 ± 70

The peat sample (NB 90-69-20(b)) was a surface collection on marsh sediments above the Lake Agassiz clay. This underwater Holocene peat or organic-rich marsh sediments with reworked Paleozoic carbonates was on the foreshore of an eroding beach.

Comment (E. Nielsen): The sample of black humus (peat) on the foreshore of Lake Winnipeg was exposed during low water level. The surface, which is usually underwater and has no plant growth, is stratigraphically above the Lake Agassiz clay, and forms part of a Holocene marsh sequence that is being slowly eroded by Lake Winnipeg. The date will provide information on the rate of southward transgression of Lake Winnipeg as well as the end of the Hypsithermal.

BGS-1442 Patricia Beach

uncorrected age: 190 ± 65

The wood (*Populus*; identified by E. Nielsen) was enclosed in sand and gravel. Sample NB-90-69-5(a) was collected by E. Nielsen on July 6, 1990, from Patricia Beach on the southeast shore of the south basin of Lake Winnipeg, Manitoba (50°26'10"N, 96°35'20"W), at an elevation of 217.4 m. This sample was submitted by E. Nielsen to gain information on the beach foreshore, and the rate of transgression of Lake Winnipeg.

Comment (E. Nielsen): The wood was collected at the water's edge on the foreshore of Patricia Beach. This date will help to determine the rate of transgression of Lake Winnipeg.

BGS-1444 Beaconia Beach I

uncorrected age: 185 ± 65

The wood (*Salix*; identified by E. Nielsen) was enclosed in sand. Sample NB-90-69-8(i) was collected by E. Nielsen on July 11, 1990, from Beaconia Beach on the southeastern shore of the south basin of Lake Winnipeg, Manitoba (50°26'30"N, 96°34'50"W), at an elevation of 217.4 m. This sample was submitted by E. Nielsen to gain information on the beach foreshore, and the rate of transgression of Lake Winnipeg.

Comment (E. Nielsen): The stumps were sticking out of the water 7.5 m from the shore in a water depth of about 55 cm, and the distance to the lagoon was about 50 m. The outside of the tree stumps were covered with green algae so the outer 0.5 cm was cut off prior to dating. This date will help to determine the rate of transgression of Lake Winnipeg.

BGS-1445 Beaconia Beach II

normalized age: modern

The wood (rooted tree) was a sub-aerial collection in the lagoon. Sample NB-90-69-8(j) was collected by E. Nielsen on July 11, 1990, from the lagoon behind Beaconia Beach on the southeastern shore of the south basin of Lake Winnipeg, Manitoba (50°26'30"N, 96°34'30"W), at an elevation of 217.4 m. This sample was submitted by E. Nielsen to gain information on the foreshore lagoon, and the rate of transgression of Lake Winnipeg.

Comment (E. Nielsen): The tree was sticking out of the lagoon about 100 m from the nearest living trees. There was some lichen growth on the outside of stump and some burrowing insects inside. The water level in the lagoon was at about ground level where the tree was rooted. This date will help to determine the rate of transgression of Lake Winnipeg.

BGS-1443 Beaconia Beach III

uncorrected age: 260 ± 80

The organic muck was enclosed in silty clay. Sample NB 90-69-8(a) was collected by E. Nielsen on July 11, 1990, from Beaconia Beach on the southeastern shore of the south basin of Lake Winnipeg, Manitoba (50°26'50"N, 96°34'35"W), at an elevation of 217.4 m. This sample was submitted by E. Nielsen to gain information on the beach foreshore, and the rate of transgression of Lake Winnipeg.

Comment (E. Nielsen): The collection site was underwater on the foreshore about 1 m from the water's edge and about 44 m from the lagoon. There may have been some modern green algae present. This date will help to determine the rate of transgression of Lake Winnipeg.

CAMS-35496 about 10 km offshore

normalized age: 3550 ± 70

The sunflower seed (organic; *Helianthus*; identified by A.M. Telka) was enclosed in the base of calcareous mud and sand directly above sharp contact overlying sand. Core '96900 LW 224 PC' was collected

by C.F.M. Lewis on September 3, 1996, from about 10 km off the southern shoreline in the south basin of Lake Winnipeg, Manitoba (50°33.0'N, 96°47.2'W), at an elevation of 217.9 m; the water depth was 8.5 m; 7.31 m of lake sediment was recovered from 10 cm diameter piston core. This sample was submitted by C.F.M. Lewis to gain information on the lake level change in Lake Winnipeg, and compare the dating of different taxa.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 7.31 m Lake Winnipeg sediment (5.50 m clay and silty clay over 0.32 m interlaminated mud and sand over 1.49 m sand) recovered with a 10 cm diameter by 9 m long piston corer in 8.5 m water depth. The dated sunflower seed (577-582 cm) was from the base of 32 cm-thick, organic-rich, interlaminated mud and sand unit with wood fragments and small gastropod shells, resting directly on a sharp contact underlain by fine to medium calcareous sand including some coarse sand with mud clasts and mollusc shells, the latter particularly abundant below 7.00 m down-core. The sample elevation of 202.9 m asl is based on acoustic profile and seismic reflection travel time to the top of calcareous sand unit (Lewis et al., 2000).

Comment (A.M. Telka and D.L. Forbes): This was the southernmost core in Namao 94900 and 96900 series. The preservational state of the sunflower (*Helianthus*) seed was excellent. The assemblage has been minimally transported, as evidenced by the excellent preservational state of most of the macrofossils. The shoreline at 3.5 ka was much closer to the core site than the modern shoreline (10 km from core site) based upon plant and insect macrofossil evidence. This date is a crosscheck for comparing dating results between an upland shoreline taxon (*Helianthus*) and an aquatic emergent (*Scirpus*; CAMS-35501) with an age difference of 20 ± 50 years. See Fossil Arthropod and Plant Macrofossil Report: 97-15 (below).

CAMS-35501 about 10 km offshore

normalized age: 3570 ± 120

The 2 bulrush seeds (*Scirpus*; identified by A.M. Telka) were enclosed in Lake Winnipeg sandy mud with organics directly above sharp contact over sand. Core '96900 LW 224 PC' was collected by C.F.M. Lewis on September 3, 1996, from about 10 km from the southern shoreline in the south basin of Lake Winnipeg, Manitoba (50°33.0'N, 96°47.2'W), at an elevation of 217.9 m; water depth was 8.5 m; 7.31 m lake sediment recovered from 10 cm diameter piston core. The sample was submitted by C.F.M. Lewis to gain information on the submerged paleoshoreline, and compare the dating of different taxa.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 7.31 m Lake Winnipeg sediment (5.50 m clay and silty clay over 0.32 m interlaminated mud and sand over 1.49 m sand) recovered with a 10 cm diameter by 9 m long piston corer in 8.5 m water depth. Dated bulrush seeds (0.9 mg, 577-582 cm) were from the base of 32 cm-thick, organic-rich, interlaminated calcareous silt-clay mud and sand unit with wood fragments and small gastropod shells, resting directly on a sharp contact underlain by fine to medium calcareous sand including some coarse sand with mud clasts and mollusc shells, the latter particularly abundant below 7.00 m down-core. The sample elevation of 202.9 m asl is based on acoustic profile and seismic reflection travel time to the top of calcareous sand unit (Lewis et al., 2000).

Comment (A.M. Telka and D.L. Forbes): This was the southernmost core in Namao 94900 and 96900 core series. The preservational state of dated *Scirpus* seeds was good with remnant basal bristles still attached as well as pristine style tip. The assemblage has been minimally transported as evidenced by the excellent preservational state of most of the macrofossils. The shoreline at 3.5 ka was much closer to the core site than now, based on plant and insect macrofossil evidence. This date is a cross-check for comparing dating results between aquatic emergent (*Scirpus*) and upland shoreline (*Helianthus*; CAMS-35496) taxa with an age difference of 20 ± 50 years.

Fossil Arthropod and Plant Macrofossil Report: 97-15 (A.M. Telka)
Sample No.: 96900 Lake Winnipeg Core 224
Laboratory No.: 2-40
Interval: 577-582 cm below water sediment interface
Water Depth: 8.5 m
Material: calcareous mud and sand
Sample Vol.: 80 mL (wet)

PLANT MACROFOSSILS:		
Fungal Remains:		
fungal sclerotia	+	1
Algal Remains:		
Characeae		
Chara/Nitella type	+	oogonia: 11
Non Vascular Plants:		
Bryophytes ....."mosses"	+	leaf: 1
Vascular Plants:		
Sparganiaceae ..."bur reed family"		
Sparganium spp.	+	seeds: 2 (one seed with large 'flecks' of vivianite on seed coat)
Typhaceae ....."cat-tail family"		
Typha sp.	+	seeds: 4.5
Alismaceae ....."water plantain family"		
Sagittaria sp.	+	seed embryo: 1
Gramineae ....."grass family"	+	seeds: 3.5
Cyperaceae ....."sedge family"		
Scirpus spp.	+	seeds: large-2, small-7 (two with bristles), half seed fragment: 1
Polygonaceae ...."buckwheat family"		
Polygonum lapathifolium type	+	seeds: 3 (one with vivianite on outer surface)
Polygonum/Rumex type	+	seed: 1
Polygonum amphibium L.	+	seed: 1
Rumex sp.	+	calyx: 2, seed with calyx: 1
Chenopodiaceae .."goosefoot family"		
Chenopodium sp.	+	seeds: 5.5, fragments: 3
Salicornia rubra A. Nels.	+	seed: 1
Caryophyllaceae? "pink family"	+	seed: 1
Rosaceae ....."rose family"		
Potentilla sp.	+	seed: 1
Labiatae ....."mint family"		
Mentha? sp.	+	seed fragment: 1
Compositae ...."composite family"		
Helianthus sp.	+	seed: 1 (well preserved), seed fragment: 1
Unidentified plant taxa	+	seeds: 2, seed fragments: 3
Other:		
wood	+	'chunks' of wood, bark
net-veined leaves	+	fragments: 20
charcoal	+	fragments: 18
bark	+	fragment: 1
soft coal	+	fragments: 5

ANIMAL MACROFOSSILS:		
PORIFERA ....."sponges"		
HAPLOSCLERINA		
Spongillidae		
Spongilla type	+	single cells: 13
ARTHROPODA		
INSECTA		
EPHEMEROPTERA ..."mayflies"	+	larval mandibles: 10
HEMIPTERA ....."bugs"		
Corixidae ....."water boatmen"	+	hemelytral fragments: 5
COLEOPTERA ....."beetles"		
Carabidae ....."ground beetles"		
Bembidion anguliferum grp.	+	pronotum: 1
Hydrophilidae ..."water scavenger beetles"	+	elytron: 1
Hydraenidae ..."minute moss beetles"		
Ochthebius sp.	+	elytra: 2, head: 1
Lathridiidae ...."minute brown scavenger beetles"	+	elytron: 1
TRICHOPTERA ....."caddisflies"	+	larval frontoclypeal apotomes: 4, case fragments: 2
DIPTERA ....."flies"	+	articulated thoraces and abdomens: 3, puparial fragment: 1
Chironomidae ...."midges"	+	larval head capsules: 15
HYMENOPTERA ....."wasps and ants"		
Ichneumonoidea .."ichneumons and braconids"	+	thorax: 1
Formicidae ....."ants"	+	head: 1
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	+	ephippia: 27
Ostracoda ....."ostracodes"	++	valves: 242, intact valves: 13
MOLLUSCA	+	many fragments
Gastropoda ....."snails, limpets"	+++	complete snails: about 236 (many varieties)
Pelecypoda ....."clams, mussels"	++	valves: 18, intact valves: 9
Unidentifiable animal taxa	+	head-flea?
Other:		
fish scale	+	complete: 1, frag.: 1
vertebra	+	1
claw	+	1
bone	+	fragment: 1
vivianite	+	fragment: 1
cocoon	+	fragments: 2

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 250 microns (0.25 mm)

CAMS-35615 about 10 km offshore

normalized age: 4090 ± 60

The freshwater pelecypod shell, whole valve (unidentified) was enclosed in near base of highly calcareous sand under mud and sand. Core '96900 LW 224 PC' was collected by C.F.M. Lewis on September 3, 1996, from about 10 km from the southern shoreline in the south basin of Lake Winnipeg, Manitoba (50°33.0'N, 96°47.2'W), at an elevation of 217.9 m; water depth was 8.5 m; 7.31 m lake sediment recovered from 10 cm diameter piston core. This sample was submitted by C.F.M. Lewis to gain information on lake level change, and the submerged paleoshoreline.

Assuming a $\delta^{13}C$ of -7‰, the age was normalized to a $\delta^{13}C$ of -25‰.

Stratigraphy: 7.31 m Lake Winnipeg sediment (5.50 m clay and silty clay over 0.32 m interlaminated mud and sand over 1.49 m sand) recovered with a 10 cm diameter by 9 m long piston corer in 8.5 m water depth. Dated pelecypod valve (705-710 cm) was from zone of abundant shell material near base of calcareous sand in core, about 1.25 m below sharp contact at the top of this sand. The sample elevation of 201.6 m asl is based on acoustic profile and seismic reflection travel time to the top of calcareous sand unit (Lewis et al., 2000).

Comment (A.M. Telka and D.L. Forbes): The state of preservation of the dated shell was good with periostracum intact. The plant and insect macrofossil assemblage was mostly shoreline and emergent type plants with both terrestrial and aquatic insect components. This shell age of 4.1 ka is about 0.5 ka older than the overlying dated *Scirpus*; and *Helianthus*; seeds (3.5 ka), suggesting a reservoir correction of less than 500 years.

Fossil Arthropod and Plant Macrofossil Report: 97-16 (A.M. Telka)
Sample No.: 96900 Lake Winnipeg Core 224
Interval: 705-710 cm below water sediment interface
Laboratory No.: 2-38.5
Water Depth: 8.5 m
Material: highly calcareous sand
Sample Vol.: 80 mL (wet)

PLANT MACROFOSSILS:		
Algal Remains:		
Characeae		
Chara/Nitella type	+	oogonium: 1
Non Vascular Plants:		
Bryophytes ....."mosses"	+	leaves: 2
Vascular Plants:		
Gramineae? ....."grass family"	+	seed fragments: 2
Cyperaceae ....."sedge family"		
Scirpus sp.	+	seed: 1 (poorly preserved)
Rosaceae ....."rose family"		
Potentilla sp.	+	seed: 1
Potentilla paradoxa Nutt.	+	seed: 1
Haloragaceae ...."water milfoil family"		
Myriophyllum sp.	+	seed: 1
Plantaginaceae .."plantain family"		
Plantago major L.	+	seed: 1
Compositae ...."composite family"		
Helianthus sp.	+	seed fragments: 9
Unidentified plant taxa	+	seed fragments: 3
Unknown "a"	+	seed: 1
Other:		
wood/twigs	+	about 5 (one fragment is 1 cm long), some with bark, few with rounded ends, various states of preservation
net-veined leaves	+	fragments: 11
bark	+	fragments: 8
charcoal	+	fragments: 6
ANIMAL MACROFOSSILS:		
PORIFERA ....."sponges"		
HAPLOSCLERINA		
Spongillidae		
Spongilla type	+	colony 'mats': 9
ARTHROPODA		
INSECTA		
EPHEMEROPTERA ..."mayflies"	+	larval mandible: 1
HEMIPTERA ....."bugs"		
Corixidae ....."water boatmen"	+	hemelytral fragment: 1

COLEOPTERA ....."beetles"	+	misc. fragments, clypeus, sternites
Carabidae ....."ground beetles"		
Bembidion sp.	+	elytral fragment: 1
Helodidae ....."marsh beetles"	+	elytral fragment: 1
TRICHOPTERA ....."caddisflies"	+	case fragments: 2
DIPTERA ....."flies"		
Tipulidae ....."crane flies"		
Tipula sp.	+	head: 1
Chironomidae ...."midges"	+	larval head capsules: 10.5
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	+	ephippia: 5
Ostracoda ....."ostracodes"	+	valves: 21, intact valves: 2
ARACHNIDA		
Oribatei/Acari .."mites"	+	1
MOLLUSCA		
Gastropoda ....."snails, limpets"	+	23 complete snails, many fragments
Pelecypoda ....."clams, mussels"	+	valves: 18 including large bivalves (one with periostracum intact)
Other:		
bones	+	4 pieces (one is large, worn)
fish scales	+	fragment: 1

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 250 microns (0.25 mm)

CAMS-46192 about 10 km offshore

normalized age: 5350 ± 50

The bulrush seed (*Scirpus*; identified by A.M. Telka) was enclosed in the top of highly calcareous sand, directly below sharp contact under mud and sand. Core '96900 LW 224 PC' was collected by C.F.M. Lewis on September 3, 1996, from about 10 km from the southern shoreline in the south basin of Lake Winnipeg, Manitoba (50°33.0'N, 96°47.2'W), at an elevation of 217.9 m. This sample was submitted by C.F.M. Lewis to gain information on the submerged shoreline in Lake Winnipeg.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 7.31 m Lake Winnipeg sediment (5.50 m clay and silty clay over 0.32 m interlaminated mud and sand over 1.49 m sand) recovered with a 10 cm diameter by 9 m long piston corer in 8.5 m water depth. The dated bulrush seed (584-589 cm) was from the top of the lower sand unit (a fine to medium calcareous sand including some coarse sand with mud clasts and mollusc shells), directly below a sharp contact overlain by interlaminated organic-rich silt-clay mud and sand. The sample elevation of 202.85 m asl is based on acoustic profile and seismic reflection travel time to the top of calcareous sand unit (Lewis et al., 2000).

Comments (A.M. Telka and C.F.M. Lewis): The preservational state of the dated bulrush seed was poor (outer surface showing signs of mechanical abrasion). This age estimate of 5.3 ka is the oldest date obtained from the south basin. Based on younger dates from this core, including a younger shell age of 4.0 ka (CAMS-35615) lower in the sand, and the poor preservational state of the dated bulrush seed, this sample is believed to be reworked. The dated seed may represent an episode of earlier seasonal ponding in the south basin.

Fossil Arthropod and Plant Macrofossil Report: 98-38 (A.M. Telka)
Sample No.: 96900 Lake Winnipeg Core 224
Interval: 584-589 cm below water sediment interface
Laboratory No.: 2-36.5
Water Depth: 8.5 m
Material: highly calcareous sand
Sample Vol.: 90 mL (wet)

PLANT MACROFOSSILS:		
Fungal Remains:		
fungal sclerotia	+	1
Algal Remains:		
Characeae		
Chara/Nitella type	+	oogonia: 5 (two with outer calcium coat intact)
Non Vascular Plants:		
Bryophytes ....."mosses"	+	stems only
Vascular Plants:		
Typhaceae ....."cat-tail family"		
Typha sp.	+	seed: 1
Potamogetonaceae .."pondweed family"		
Zanichellia palustris L.	+	seed: 1
Alismaceae ...."water plantain family"		
Sagittaria sp.	+	seeds: 2
Gramineae? ....."grass family"	+	seed: 1
Cyperaceae ....."sedge family"		
Carex trigonous type	+	seed: 1
Scirpus spp.	+	seeds: 4.5
Salicaceae ....."willow family"		
Salix sp.	+	seed capsule: 1
Polygonaceae ...."buckwheat family"		
Polygonum lapathifolium type	+	seed: 1
Rumex sp.	+	seed: 1
Chenopodiaceae .."goosefoot family"		
Chenopodium sp.	+	seeds: 7, fragment: 1
Labiatae ....."mint family"		
Lycopus sp.	+	seed: 1
Mentha sp.	+	seed: 1
Other:		
net-veined leaf fragments	+	
bark	+	
ANIMAL MACROFOSSILS:		
ARTHROPODA		
INSECTA		
EPHEMEROPTERA ..."mayflies"	+	larval mandibles: 3
HOMOPTERA		
Cicadellidae? ..."leafhoppers"	+	fragment: 1
COLEOPTERA ....."beetles"		
Dytiscidae ....."predaceous diving beetles"	+	ventral fragment: 1
Staphylinidae ..."rove beetles"	+	elytron: 1
Chrysomelidae ..."leaf beetles"	+	articulated head and pronotum: 1, elytron: 1
TRICHOPTERA ....."caddisflies"	+	larval traps: 17 fragments (3 types)
DIPTERA ....."flies"	+	puparia: 3
Chironomidae ...."midges"	+	larval head capsules: 3.5
HYMENOPTERA ....."wasps and ants"	+	head: 1
Formicidae ....."ants"	+	head: 1
CRUSTACEA		
Ostracoda ....."ostracodes"	+	valves: 64, intact valves: 14
MOLLUSCA		
Gastropoda ....."snails, limpets"	+++	about 700 (three types)
Pelecypoda ....."clams, mussels"	++	valves: 18, intact valves: 8
Unidentifiable animal taxa	+	cocoons: 3

Other:		
bones	+++	many fragments
fish scale	+	
fish vertebrae	+	
soft coal	+	fragments: 29
rodent feces	+	

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 850 microns (0.85 mm)

BGS-1662 Grand Beach

uncorrected age: 270 ± 70

The fibrous peat was enclosed in a 10 cm bed of sandy peat overlying (50+ cm) and underlying 40 cm calcareous dune sand. Sample 'Grand Beach 93-1' from 40 cm depth was collected by E. Nielsen on September 1, 1993, along the lagoon-side of the bay-mouth bar (barrier beach) at Grand Beach, on the eastern shore of the south basin of Lake Winnipeg, Manitoba (50°33'40"N, 96°36'50"W), at an elevation of 218.5 m. This sample was submitted by E. Nielsen to gain information on lake level change, and Lake Winnipeg transgression.

Comment (E. Nielsen): The sample dates a higher-than-present level of Lake Winnipeg.

BGS-1946 Willow Point

uncorrected age: 775 ± 105

The freshwater shells (*Lampsilis radiata siliquoidea* (Barnes); identified by E. Nielsen) were enclosed in the top 20 cm of about 1.5 m-thick calcareous beach sand. Core '96-305-030' was collected by E. Nielsen and D. Forbes on August 10, 1996, from the southside of Willow Point, just south of Gimli, on the western shore of the south basin of Lake Winnipeg, Manitoba (50°35'20"N, 96°57'10"W), at an elevation of about 219 m. This sample was submitted by E. Nielsen to gain information on the lake level change in Lake Winnipeg, and beach ridge formation.

Comment (E. Nielsen): The shells from 20 cm depth are thought to date the formation of a high berm on the south side of Willow Point. The 'hardwater' error (which may vary between species) is estimated to be between 500 and 840 years in this area which is based on the dating of a pre-bomb modern sample of *Strophitus undulatus* (Say) collected at mouth of Winnipeg River in 1941 (cf. GSC-3281) and dated samples of various mollusc species and terrestrial organics at corresponding levels in cores (cf. CAMS-35501, -35496, and -35615 from core 96900-224; CAMS-35495, and -32193 from core 96900-220; CAMS-38680 and -35616 from core 96900-221). This sample may therefore be modern or (after adjustment of unknown isotopic fractionation) up to 200-500 years old.

CAMS-27258 lagoon at Willow Point

normalized age: 1100 ± 100

The 3 bulrush seeds (*Scirpus* cf. *acutus*; identified by R.E. Vance) were enclosed in the base of peaty organic-rich clay and silt (0-105 cm) overlying firm Lake Agassiz clay. Sample WP-96-2 (2.50 m) was collected by E. Nielsen on September 14, 1996, from lagoon at Willow Point, just south of Gimli, on the western shore of the south basin of Lake Winnipeg, Manitoba (50°35.62'N, 96°57.50'W), at an elevation of about 217.6 m; water depth was 145 cm. This sample was submitted by E. Nielsen to gain information on the shorezone (lagoon), and initiation of lagoon sedimentation.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: An auger sample obtained in 1.5 m of water. The dated bulrush seeds, at an elevation of 215.1 m asl, were from the base of peaty organic-rich clay and silt (0-105 cm) overlying firm Lake Agassiz clay.

Comments (A.M. Telka and R.E. Vance): The preservational state of the dated bulrush seeds was excellent with bristles and distal tips attached.

Comment (E. Nielsen): The date of 1.1 ka provides a basal age for the initiation of sedimentation in the lagoon behind Willow Point.

CAMS-27257 lagoon at Willow Point

normalized age: 750 ± 70

The 3 bulrush seeds (*Scirpus* cf. *acutus*; identified by R.E. Vance) were enclosed in base of peaty brown clay (0-35 cm) overlying stiff Lake Agassiz clay. Sample WP-96-1 (1.80 m) was collected by E. Nielsen on September 14, 1996, from lagoon at Willow Point, just south of Gimli, on the western shore of the south basin of Lake Winnipeg, Manitoba (50°35.80'N, 96°57.88'W), at an elevation of about 217.6 m; water depth was 145 cm; bulrush seeds in auger sample from 215.8 m asl. This sample was submitted by E. Nielsen to gain information on the shorezone (lagoon), and the initiation of lagoon sedimentation.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Comment (A. Telka): Preservational state of the dated bulrush seeds is excellent with bristles and distal tips attached.

Comment (E. Nielsen): The date of 0.75 ka provides a basal age for the initiation of sedimentation in the lagoon behind Willow Point.

CAMS-19445 about 30 km offshore

normalized age: 3990 ± 50
$\delta^{13}C$= -27.7‰

The bulk organic sediment was enclosed in noncalcareous clay-silt mud underlain by peat and stiff clayey silt. Core '94900 LW 122a GC' was collected by C.F.M. Lewis on August 29, 1994, from about 30 km from the southern shoreline in the central part of the south basin of Lake Winnipeg, Manitoba (50°39.39'N, 96°48.29'W), at an elevation of 217.8 m; water depth was 9.8 m; 4.77 m lake sediment recovered from 6 cm diameter gravity core. This sample was submitted by C.F.M Lewis to gain information on lake level change, and Lake Winnipeg sediments; the age is anomalously old.

The age was normalized to a $\delta^{13}C$ of -25‰.

Stratigraphy: 4.77 m lake sediment and peat recovered with a 6 cm diameter by 9 m long gravity corer in 9.8 m water depth. The dated sediment (017-023 cm) is from near the top of noncalcareous clay-silt mud (0-300 cm) about 403 cm above conformable contact (426.5 cm) underlain by peat (426.5-435 cm) and stiff clayey silt (435-472 cm). The sample elevation of 204.3 m asl is based on acoustic profile and seismic reflection travel time to the Lake Agassiz Unconformity (top of stiff clayey silt); this core was significantly shortened in the coring process (Lewis et al., 2000).

Comments (A.M. Telka and C.F.M. Lewis): This age of 4.0 ka on near-surface Lake Winnipeg sediments is anomalously old in comparison to excellently preserved *Scirpus* seed dates of 4.0 ka from deeper peat within this core (CAMS-17434 and CAMS-34551, below), probably resulting from the incorporation of carbon older than late Quaternary within the Lake Winnipeg watershed. This age determination should be ignored.

CAMS-17434 about 30 km offshore

normalized age: 4040 ± 70

The bulrush seed (*Scirpus*; identified by R.E. Vance) was enclosed in peat under a conformable contact with clay-silt mud, and over stiff clayey silt. Core '94900 LW 122a GC' was collected by C.F.M. Lewis on August 29, 1994, from about 30 km from the southern shoreline in the central part of the south basin of Lake Winnipeg, Manitoba (50°39.39'N, 96°48.29'W), at an elevation of 217.8 m; water depth was 9.8 m; 4.77 m lake sediment recovered from 6 cm diameter gravity core. This sample was submitted by C.F.M. Lewis to gain information on lake level change, and provide a basal date on Lake Winnipeg.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 4.77 m lake sediment and peat recovered in a 6 cm diameter by 9 m long gravity corer in 9.8 m water depth. The dated bulrush (*Scirpus*) seed (425-433 cm) was from a peat unit consisting of two beds of clayey silt and peat (426.5-435 cm) overlying stiff Lake Agassiz clayey silt and underlying conformable contact with Lake Winnipeg clay-silt mud. The sample elevation of 200.2 m asl is based on acoustic profile and seismic reflection travel time to the Lake Agassiz Unconformity (top of stiff clayey silt); this core was significantly shortened in the coring process (Lewis et al., 2000).

Comments (R.E. Vance): Peat layer is the only organic-rich layer observed in the 94900 core series. The plant macrofossil assemblage was rich and varied including rush (*Juncus*), sedge (*Carex*), bulrush (*Scirpus*), skunkweed (*Chara*), horned pondweed (*Zannichellia palustris*), cat-tail (*Typha*), goosefoot (*Chenopodium*) and samphire (*Salicornia rubra* A. Nels.). The preservational state of the dated bulrush seed was excellent with basal bristles still attached and displaying a well shaped pristine style tip. Plant macrofossil evidence suggests that the core site was situated near the shoreline at 4.0 ka.

CAMS-19446 about 30 km offshore

normalized age: 5820 ± 50
$\delta^{13}C$= -27.9‰

The bulk organic sediment was enclosed in noncalcareous clay-silt mud underlain by peat and stiff clayey silt. Core '94900 LW 122a GC' was collected by C.F.M. Lewis on August 29, 1994, from about 30 km from the southern shoreline in the central part of the south basin of Lake Winnipeg, Manitoba (50°39.39'N, 96°48.29'W), at an elevation of 217.8 m; water depth was 9.8 m; 4.77 m lake sediment recovered from 6 cm diameter gravity core. This sample was submitted by C.F.M. Lewis to gain information on lake level change, and Lake Winnipeg sediments; the age is anomalously old.

The age was normalized to a $\delta^{13}C$ of -25‰.

Stratigraphy: 4.77 m lake sediment and peat recovered with a 6 cm diameter by 9 m long gravity corer in 9.8 m water depth. The dated sediment (118-123 cm) was from within noncalcareous clay-silt mud (0-300 cm) about 303 cm above conformable contact (426.5 cm) underlain by peat (426.5-435 cm) and stiff clayey silt (435-472 cm). The sample elevation of 203.3 m asl is based on acoustic profile and seismic reflection travel time to the Lake Agassiz Unconformity (top of stiff clayey silt); this core was significantly shortened in the coring process (Lewis et al., 2000).

Comments (A.M. Telka and C.F.M. Lewis): This date of 5.8 ka on Lake Winnipeg sediments is anomalously old in comparison to the excellently preserved *Scirpus* seed dates of 4.0 ka from deeper peat within this core (CAMS-17434 (above) and CAMS-34551 (below)), probably resulting from the incorporation of carbon older than late Quaternary within the Lake Winnipeg watershed. This age determination should be ignored.

CAMS-19447 about 30 km offshore

normalized age: 6900 ± 60
$\delta^{13}C$= -27.7‰

The bulk organic sediment was enclosed in noncalcareous clay-silt mud underlain by peat and stiff clayey silt. Core '94900 LW 122a GC' was collected by C.F.M. Lewis on August 29, 1994, from about 30 km from the southern shoreline in the central part of the south basin of Lake Winnipeg, Manitoba (50°39.39'N, 96°48.29'W), at an elevation of 217.8 m; water depth was 9.8 m; 4.77 m lake sediment recovered from 6 cm diameter gravity core. This sample was submitted by C.F.M. Lewis to gain information on lake level change, and Lake Winnipeg sediments; the age is anomalously old.

The age was normalized to a $\delta^{13}C$ of -25‰.

Stratigraphy: 4.77 m lake sediment and peat recovered with a 6 cm diameter by 9 m long gravity corer in 9.8 m water depth. The dated sediment (188-192 cm) was from within noncalcareous clay-silt mud (0-300 cm) about 234 cm above conformable contact (426.5 cm) underlain by peat (426.5-435 cm) and stiff clayey silt (435-472 cm). The sample elevation of 202.6 m asl is based on acoustic profile and seismic reflection travel time to the Lake Agassiz Unconformity (top of stiff clayey silt); this core was significantly shortened in the coring process (Lewis et al., 2000).

Comments (A.M. Telka and C.F.M. Lewis): A date of 6.9 ka on Lake Winnipeg sediments is anomalously old in comparison to the excellently preserved *Scirpus* seed dates of 4.0 ka from deeper peat within this core (CAMS-17434 (above) and CAMS-34551 (below)), probably resulting from the incorporation of carbon older than late Quaternary within the Lake Winnipeg watershed. This age determination should be ignored.

CAMS-19449 about 30 km offshore

normalized age: 7560 ± 70
$\delta^{13}C$= -28.4‰

The bulk organic sediment was enclosed in top of weakly calcareous clay-silt mud underlain by peat and stiff clayey silt. Core '94900 LW 122a GC' was collected by C.F.M. Lewis on August 29, 1994, from about 30 km from the southern shoreline in the central part of the south basin of Lake Winnipeg, Manitoba (50°39.39'N, 96°48.29'W), at an elevation of 217.8 m; water depth was 9.8 m; 4.77 m lake sediment recovered from 6 cm diameter gravity core. This sample was submitted by C.F.M. Lewis to gain information on lake level change, and Lake Winnipeg sediments.

The age was normalized to a $\delta^{13}C$ of -25‰.

Stratigraphy: 4.77 m lake sediment and peat recovered with a 6 cm diameter by 9 m long gravity corer in 9.8 m water depth. The dated

sediment (318.5-322 cm) was from near the top of weakly calcareous clay-silt mud (300-426.5 cm) about 104 cm above conformable contact (426.5 cm) underlain by peat (426.5-435 cm) and stiff clayey silt (435-472 cm). The sample elevation of 201.3 m asl is based on acoustic profile and seismic reflection travel time to the Lake Agassiz Unconformity (top of stiff clayey silt); this core was significantly shortened in the coring process (Lewis et al., 2000).

Comments (A.M. Telka and C.F.M. Lewis): The date of 7.6 ka on Lake Winnipeg sediments is anomalously old in comparison to the excellently preserved *Scirpus* seed dates of 4.0 ka from deeper peat within this core (CAMS-17434 (above) and CAMS-34551(below)), probably resulting from the incorporation of carbon older than late Quaternary within the Lake Winnipeg watershed.

CAMS-19448 about 30 km offshore

normalized age: 7570 ± 50
$\delta^{13}C$= -27.5‰

The bulk organic sediment was enclosed in base of noncalcareous clay-silt mud underlain by peat and stiff clayey silt. Core '94900 LW 122a GC' was collected by C.F.M. Lewis on August 29, 1994, from about 30 km from the southern shoreline in the central part of the south basin of Lake Winnipeg, Manitoba (50°39.39'N, 96°48.29'W), at an elevation of 217.8 m; water depth was 9.8 m; 4.77 m lake sediment recovered from 6 cm diameter gravity core. This sample was submitted by C.F.M. Lewis to gain information on lake level change, and Lake Winnipeg sediments.

The age was normalized to a $\delta^{13}C$ of -25‰.

Stratigraphy: 4.77 m lake sediment and peat recovered with a 6 cm diameter by 9 m long gravity corer in 9.8 m water depth. The dated sediment (268.5-272 cm) is from near the base of noncalcareous clay-silt mud (0-300 cm) about 154 cm above conformable contact (426.5 cm) underlain by peat (426.5-435 cm) and stiff clayey silt (435-472 cm). The sample elevation of 201.8 m asl is based on acoustic profile and seismic reflection travel time to the Lake Agassiz Unconformity (top of stiff clayey silt); this core was significantly shortened in the coring process (Lewis et al., 2000).

Comments (A.M. Telka and C.F.M. Lewis): The date of 7.6 ka on Lake Winnipeg sediments is anomalously old in comparison to the excellently preserved *Scirpus* seed dates of 4.0 ka from deeper peat within this core (CAMS-17434 (above) and CAMS-34551 (below)), probably resulting from the incorporation of carbon older than late Quaternary within the Lake Winnipeg watershed.

Beta-81335 (AMS) about 30 km offshore

normalized age: 11 050 ± 270
$\delta^{13}C$= -16.1‰

The bulk organic sediment was enclosed in weakly calcareous clay-silt mud overlying peat and Lake Agassiz clayey silt. Core '94900 LW 122a GC' was collected by C.F.M. Lewis on August 29, 1994, from about 30 km from the southern shoreline in the central part of the south basin of Lake Winnipeg, Manitoba (50°39.39'N, 96°48.29'W), at an elevation of 217.8 m; water depth was 9.8 m; 4.77 m lake sediment recovered from 6 cm diameter gravity core. This sample was submitted by C.F.M. Lewis to gain information on lake level change, and Lake Winnipeg sediments.

The age was normalized to a $\delta^{13}C$ of -25‰.

Stratigraphy: 4.77 m lake sediment and peat layer recovered within a 6 cm diameter by 9 m long gravity corer in 9.8 m water depth. The dated sediment (388.5-392 cm) was from weakly calcareous clay-silt mud (300-426.5 cm) about 35 cm above conformable contact (426.5 cm) underlain by peat (426.5-435 cm) and stiff clayey silt (435-472 cm). The sample elevation of 200.6 m asl is based on acoustic profile and seismic reflection travel time to the Lake Agassiz Unconformity (top of stiff clayey silt); this core was significantly shortened in the coring process (Lewis et al., 2000).

Comments (A.M. Telka): The date of 11.1 ka on Lake Winnipeg sediments is anomalously old in comparison to the excellently preserved *Scirpus* seed date of 4.0 ka from peat within this core (see associated dates CAMS-17434 (above) and CAMS-34551 (below)), demonstrating an apparent error, probably from the incorporation of carbon older than late Quaternary within the Lake Winnipeg watershed.

CAMS-34550 central south basin

normalized age: 3280 ± 60

The bulrush seed (*Scirpus*; identified by A.M. Telka) was enclosed in base of noncalcareous clay mud over silty clay mud, 1.7m above Lake Agassiz Unconformity. Core '96900 LW 223 PC' was collected by C.F.M. Lewis on August 30, 1996, from the central part of the south basin of Lake Winnipeg, Manitoba (50°39.4'N, 96°48.3'W), at an elevation of 217.6 m; water depth was 9.75 m; 7.39 m lake sediment recovered from 10 cm diameter piston core. This sample was submitted by C.F.M. Lewis to gain information on lake level change, and Lake Winnipeg sediments.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 7.39 m lake sediment (6.78 m of Lake Winnipeg mud over 0.1 m of silty peat and 0.52 m of crumbly organic silty clay) recovered with a 10 cm diameter by 9 m long piston corer in 9.75 m water depth. Dated bulrush seed (507-509 cm) was from the base of the uppermost unit of noncalcareous clay mud (0-509 cm) overlying silty clay mud, about 1.68 m above the Lake Agassiz Unconformity at 677.5 cm down-core. Silty peat and organic silty clay are present below the unconformity. This is a replicate of core '94900-122a'. The sample elevation of 201.7 m asl is based on acoustic profile and seismic reflection travel time to the Lake Agassiz Unconformity (Lewis et al., 2000).

Comments (A.M. Telka): The preservation of the bulrush seed was excellent with two long basal filaments and intact, pristine, style tip. This dated sample contained one of the richest and most diverse assemblages of plant and insect macrofossils examined in the *Namao* 96900 cores. The plant macrofossil assemblage included many cattail (*Typha*) fragments and well preserved bulrushes (*Scirpus*) along with a variety of shoreline plants. The insect fossil assemblage contained many well preserved shoreline types and an increase in marsh beetles (Helodidae). The combined fossil evidence suggests a shallow marsh environment with shoreline near the core site at 3.3 ka. The present Lake Winnipeg shoreline is about 10 km away to the east and west and 30 km to the south.

Fossil Arthropod and Plant Macrofossil Report: 97-13 (A.M. Telka)
Sample No.: 96900 Lake Winnipeg Core 223
Interval: 507-509 cm below water sediment interface
Laboratory No.: 2-9-1
Water Depth: 9.8 m
Material: noncalcareous clay mud
Sample Vol.: 90 mL (wet)

PLANT MACROFOSSILS:		
Algal Remains:		
Characeae		
Chara/Nitella type	+	oogonia: 5
Non Vascular Plants:		
Bryophytes ....."mosses"		
Drepanocladius type	+	leaves: 2
Vascular Plants:		
Typhaceae ....."cat-tail family"		
Typha sp.	++	seeds: 24
Potamogetonaceae ."pondweed family"		
Potamogeton sp.	+	seed: 1
Alismaceae ...."water plantain family"		
Sagittaria sp.	+	seeds: 2
Gramineae ....."grass family"	+	seeds: 2.5
Cyperaceae ....."sedge family"		
Carex lenticular type	+	seeds: 2
Carex trigonous type	+	seeds: 2.5 (one seed is charred)
Eleocharis sp.	+	seed: 1
Scirpus spp.	+++	seeds: large-13 (8 with bristles), medium-4, small-17 (8 with basal bristles), fragments-7
Juncaceae ....."rush family"		
Juncus/Luzula type	+	seed: 1
Polygonaceae ...."buckwheat family"		
Polygonum lapathifolium type	+	seed fragments: 2
Rumex sp.	+	seeds: 2
Chenopodiaceae .."goosefoot family"		
Chenopodium sp.	+	half seeds: 2
Rosaceae ....."rose family"		
Potentilla sp.	+	seed: 1
Potentilla paradoxa Nutt.	+	seed: 1
Umbelliferae ...."parsley family"		
Sium suave Walt.	+	seed: 1
Compositae ...."composite family"	+	seed: 1
Helianthus sp.	+	seed: 1
Unidentified plant taxa	+	seeds: 2, charred seed: 1, seed fragments: 2
Other:		
net-veined leaves	+	fragment: 1
charcoal	+	pieces: 3
wood	+	mostly fragments with no bark, few twigs (one is 'fire hardened'), bark fragments
ANIMAL MACROFOSSILS:		
BRYOZOA		
Cristatella mucedo L.	+	statoblast: 1
ARTHROPODA		
INSECTA		
EPHEMEROPTERA ..."mayflies"	+	larval mandibles: 34
HEMIPTERA ....."bugs"	+	pronota: 4, heads: 2 (two different kinds)
Corixidae ....."water boatmen"	+	pronotum: 1
HOMOPTERA		
Cicadellidae ...."leafhoppers"	+	head: 1
COLEOPTERA ....."beetles"	+	misc. fragments: legs, prosternum, sternites, elytron: 1, head: 1
Carabidae ....."ground beetles"	+	prothorax: 1
Bembidion sp.	+	pronota: 2.5, elytron: 1, heads: 2
Agonum sp.	+	elytron: 1
Dytiscidae ....."predaceous diving beetles"	+	half elytron: 1
Gyrinidae ...."whirligig beetles"	+	elytral fragment: 1
Hydrophilidae ..."water scavenger beetles"	+	head: 2, pronotum: 1
Hydraenidae .."minute moss beetles"		
Ochthebius sp.	+	elytron: 1
Staphylinidae ..."rove beetles"	+	head fragment: 1, elytra: 4, articulated head and prothorax: 2, pronotum: 1
Olophrum rotundicolle (Sahlb.)	+	pronotum: 1
Stenus sp.	+	elytron: 1
Quedini	+	head fragment: 1, pronotum: 1
Aleocharinae	+	prothorax: 1
Helodidae ....."marsh beetles"	+	elytra: 2, pronota: 3.5, heads: 4, elytral fragments: 5
Byrrhidae ....."pill beetles"	+	pronotum: 1
Chrysomelidae ..."leaf beetles"	+	elytral fragment: 1
Curculionidae ..."weevils"	+	head: 1
Ceutorhynchus sp.	+	elytron: 1
TRICHOPTERA ....."caddisflies"	+	case fragment: 1
DIPTERA ....."flies"	+	thoraces: 29, heads: 5
Chironomidae ...."midges"	+	larval head capsules: 97
HYMENOPTERA ....."wasps and ants"	+	heads: 5
Ichneumonoidea ...."ichneumons and braconids"	+	thoraces: 2
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	++	ephippia: 79
Notostraca ....."tadpole shrimp"		
Lepiduris sp.	+	mandibles: 2
Ostracoda ....."ostracodes"	+++	valves: about 1550, intact valves: 30
ARACHNIDA		
Araneae ....."spiders"	+	cephalothoraces: 2
MOLLUSCA	+	shell fragments
Gastropoda ....."snails, limpets"	+++	150
Pelecypoda ....."clams, mussels"	++	valves: 30 (some with periostracum attached)
Unidentifiable animal taxa	++	larval manidbles: about 75, larval head: 1
Other:		
bone	+	fragments: 2
claw-bone	+	1
vertebrae	+	4
fish scale	+	complete: 1, fragment: 1
soft bodied insect fragments	++	
egg cases	+	4
mandibles	+	3

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 250 microns (0.25 mm)

CAMS-34551 central south basin

normalized age: 4000 ± 60

The bulrush seed (organic; *Scirpus*; identified by A.M. Telka) was enclosed in calcareous Lake Winnipeg silty clay mud about 11 cm above Lake Agassiz Unconformity. Core '96900 LW 223 PC' was collected by C.F.M. Lewis on August 30, 1996, from the central part of the south basin of Lake Winnipeg, Manitoba (50°39.4'N, 96°48.3'W), at an elevation of 217.6 m; water depth was 9.8 m; 7.39 m lake sediment recovered from 10 cm diameter piston core. This sample was submitted by C.F.M. Lewis to gain information on lake level change, and provide a basal date on Lake Winnipeg sediments.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 7.39 m lake sediment (6.78 m of Lake Winnipeg mud over 0.1 m of silty peat and 0.52 m of crumbly organic silty clay) recovered with a 10 cm diameter by 9 m long piston corer in 9.75 m water depth. The dated bulrush seed (661-666 cm) was from calcareous Lake Winnipeg silty clay mud about 0.11 m above Lake Agassiz Unconformity at 677.5 cm down-core. Silty peat and organic silty clay are present below the unconformity. This is a replicate of core '94900-122a'. The sample elevation of 200.2 m asl is based on acoustic profile and seismic reflection travel time to the Lake Agassiz Unconformity (Lewis et al., 2000).

Comments (A.M. Telka and D.L. Forbes): The preservation of the dated bulrush seed was fair (remnant basal filaments, style tip worn). Plant macrofossils were minimally represented, and insects were rare. The combined plant macrofossil and insect fossil evidence suggests that the shoreline was near the core site at 4.0 ka. The present Lake Winnipeg shoreline is about 10 km away to the east and west and 30 km to the south, indicating significant expansion and deepening of the lake in this area over the past 4000 radiocarbon years.

Fossil Arthropod and Plant Macrofossil Report: 97-14 (A.M. Telka)
Sample No.: 96900 Lake Winnipeg Core 223
Interval: 661-666 cm below water sediment interface
Laboratory No.: 2-9-2
Water Depth: 9.8 m
Material: calcareous silty clay mud
Sample Vol.: 90 mL (wet)

PLANT MACROFOSSILS:		
Algal Remains:		
Characeae		
Chara/Nitella type	+	oogonia: 11
Vascular Plants:		
Typhaceae ....."cat-tail family"		
Typha sp.	+	seed: 1
Najadaceae ....."naiad family"		
Najas flexilis (Willd.)	+	seed fragment: 1
Gramineae ....."grass family"	+	seed: 1
Cyperaceae ....."sedge family"		
Carex sp.	+	seeds: 2 with perigynum intact
Eleocharis sp.	+	half seed: 1
Scirpus sp.	+	seed: 1 (large) with iron pyrite on surface
Juncaceae ....."rush family"		
Juncus/Luzula type	+	seed: 1
Polygonaceae ....."buckwheat family"		
Polygonum lapathifolium type	+	seed: 1
Rumex sp.	+	seed: 1, calyx fragment: 1
Chenopodiaceae ...."goosefoot family"		
Chenopodium spp.	+	seeds: 6.5
Rosaceae ....."rose family"		
Potentilla norvegica L.	+	seed: 1
Potentilla sp.	+	seed: 1
Potentilla paradoxa Nutt.	+	seeds: 6
Compositae ...."composite family"	+	seed: 1
Helianthus sp.	+	seed fragments: 2
Unidentified plant taxa	+	seeds: 2
Other:		
net-veined leaves	+	fragment: 1
charcoal	+	
ANIMAL MACROFOSSILS:		
BRYOZOA		
Plumatella type	+	statoblasts: 15
ARTHROPODA		
INSECTA	+	leg fragments, ovipositor, larval head
EPHEMEROPTERA ..."mayflies"	+	mandibles: 7
HEMIPTERA ....."bugs"		
Corixidae ....."water boatmen"	+	hemelytral fragment: 2
COLEOPTERA ....."beetles"	+	articulated femur and tibia: 2, sternites: 2, mesosternum: 1, elytral fragments: 2
Carabidae ....."ground beetles"	+	head
Staphylinidae ..."rove beetles"		
Aleocharinae	+	elytra: 2, pronotum: 1, pro- and mesosternum: 1
Helodidae ....."marsh beetles"	+	half pronotum: 1
DIPTERA ....."flies"	+	puparium: 1, thoraces: 2
Chironomidae ...."midges"	+	larval head capsules: 34.5
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	+	ephippia: 23
Ostracoda ....."ostracodes"	++	valves and intact valves: about 200
ARACHNIDA		
Araneae ....."spiders"	+	cephalothorax: 1, palp: 1
MOLLUSCA		
Gastropoda ....."snails, limpets"	+	about 3 complete, many fragments
Pelecypoda ....."clams, mussels"	+	valves: 2, few fragments
Other:		
bone	+	fragments: 3
fish scale	+	fragment: 1
iron pyrite	++	large and small pieces, some fossils with iron pyrite on surfaces

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 250 microns (0.25 mm)

CAMS-46186 central south basin

normalized age: 4030 ± 50

The bulrush seed (organic; *Scirpus*; identified by A.M. Telka) was enclosed in organic silty clay 20 cm below Lake Agassiz Unconformity under silty clay mud and clay mud. Core '96900 LW 223 PC' was collected by C.F.M. Lewis on August 30, 1996, from central part of the south basin of Lake Winnipeg, Manitoba (50°39.4'N, 96°48.3'W), at an elevation of 217.6 m; water depth was 9.8 m; 7.39 m lake sediment recovered from 10 cm diameter piston core. This sample was submitted by C.F.M. Lewis to gain information on lake level change, and the initiation of Lake Winnipeg sedimentation.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 7.39 m lake sediment (6.78 m of Lake Winnipeg mud over 0.1 m of silty peat and 0.52 m of crumbly organic silty clay) recovered with a 10 cm diameter by 9 m long piston corer in 9.75 m water depth. The dated bulrush seed (721-726 cm) was from an organic-rich ball in silty clay, about 44 cm below the base of soft mud. Silty peat and organic silty clay are present below the unconformity, as well as a basal unit of sucked-in soft mud (re-cored material). This is a replicate of core '94900-122a'. The sample elevation of 199.6 m asl is based on acoustic profile and seismic reflection travel time to the base of soft mud (Lewis et al., 2000).

Comments (A.M. Telka and D.L. Forbes): The preservation state of the dated bulrush seed was good. Organics within this interval were in a ball form with the surrounding sediment being firm, crumbly, Lake Agassiz silty clay. It is therefore probable that the sample post-dates Lake Agassiz deposition, but was introduced at depth either through subaerial cracks in the Lake Agassiz surface (see BGS-1477, p. 60), by ice scour disturbance, or in the coring process. The date of 4.0 ka

provides an age estimate for the beginning of Lake Winnipeg sedimentation in the south basin.

Fossil Arthropod and Plant Macrofossil Report: 98-31 (A.M. Telka)
Sample No.: 96900 Lake Winnipeg Core 223 PC
Inverval: 721-726 cm below water sediment interface
Laboratory No.: 2-97
Water Depth: 9.8 m
Material: organic silty clay
Sample Vol.: 90 mL (wet)

PLANT MACROFOSSILS:		
Algal Remains:		
Characeae		
Chara/Nitella type	+	oogonia: 24
Vascular Plants:		
Alismaceae ....."water plantain family"		
Sagittaria sp.	+	seed embryo: 1
Gramineae ....."grass family"	+	seeds: 4
Cyperaceae ....."sedge family"		
Carex sp.	+	seeds: 2 (one is poorly preserved)
Eleocharis spp.	+	seeds: 3
Scirpus sp.	+	seed: 1, fragments: 3, note-some fragments are charred half seeds, one has iron pyrite 'spheres' adhering to the surface
Polygonaceae ...."buckwheat family"		
Rumex sp.	+	seeds: 3
Chenopodiaceae .."goosefoot family"		
Chenopodium spp.	+	seeds: 8.5, fragments: 9
Rosaceae ....."rose family"		
Potentilla sp.	+	seed: 1
Unidentified plant taxa	+	seed: 1
Other:		
wood	+	fragments: few
charcoal	+	fragments: few
ANIMAL MACROFOSSILS:		
TUBELLARIA ....."flatworms"	+	cocoons: 10
BRYOZOA		
Cristatella mucedo L.	+	statoblasts: 1.5
ARTHROPODA		
INSECTA		
HOMOPTERA		
Cicadellidae ...."leafhoppers"	+	head: 1
COLEOPTERA ....."beetles"	+	prosternum: 1, elytral fragment: 1
Gyrinidae ....."whirligig beetles"	+	elytron: half
Ptiliidae ...."feather-winged beetles"		
Acrotrichus sp.	+	articulated head and pronotum: 1, articulated elytra and prosternum: 1
Genus?	+	articulated elytra and prosternum: 1
Lathridiidae ... "minute brown scavenger beetles"	+	articulutated head and pronotum: 1
Curculionidae ..."weevils"	+	prothorax: 1
DIPTERA ....."flies"		
Chironomidae ...."midges"	+	larval head capsules: 5.5
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	+	ephippia: 3
Ostracoda ....."ostracodes"	+	valves: 6, fragments: 3
ARACHNIDA		
Araneae ....."spiders"	+	cephalothorax: 1
MOLLUSCA		
Gastropoda ....."snails, limpets"	+	whole: 3, fragments: 16
Other:		
iron pyrite 'sphere' clusters	+	

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 250 microns (0.25 mm)

GSC-3281 Traverse Bay

normalized age: 840 ± 100
$\delta^{13}C$= -7.9‰
uncorrected age: 570 ± 100.

The freshwater shells (*Strophitus undulatus*; identified by E. Nielsen) were a surface collection on the modern beach. Sample E.N.-1979-3 was collected by W.H. Rand in May, 1941, from Traverse Bay, about 8 km northwest of the mouth of the Winnipeg River on the southeastern shore of the south basin of Lake Winnipeg, Manitoba (50°40'N, 96°35'W), at an elevation of 217 m. This sample was submitted by E. Nielsen to gain information on the 'hardwater' error associated with freshwater shells.

Coordinates were originally given as 51°40'N 96°35'W.

Comment (E. Nielsen): The sample was dated to determine the error due to recycled old carbon in radiocarbon dates on freshwater shells from the area of Winnipeg River which is underlain by highly calcareous sediments. The date suggests that radiocarbon dates on freshwater molluscs of greater antiquity from this area could be several hundred years too old (cf. Nielsen et al., 1982).

Comment (W. Blake, Jr.): Caution must be used in applying the 'apparent age' of this pelecypod sample to other species of freshwater molluscs collected at other sites. The aragonitic paired valves comprising this sample were whole and the periostracum was intact except in the hinge area. The inside of the shells was characterized by pearly lustre.

Elk Island Series

A series of fine fibrous sedge peat samples from Elk Island, 3.2 km north of Victoria Beach on the western shore of the south basin of Lake Winnipeg, Manitoba (50°44'N, 96°33'W), at an elevation of about 217 m, was collected by A. Swedlo on July 6, 1973. These samples were submitted by F. Penner to gain information on lake level submergence in Lake Winnipeg.

Note: The coordinates for this site were reported as 50°44'N 90°33'W in Lowdon and Blake, 1979.

GSC-1977 Elk Island I

uncorrected age: 1660 ± 60

The peat sample ('Lk. Winnipeg-1973-1 (bottom))'; *Salix*, Cyperaceae and *Scirpus*; identified by J. Stewart) was enclosed in peat underlying 2.9 m wind-and water-sorted sand and gravel and underlain by clay. The sample was from the bottom 1 cm of a 3.1 m-long core.

GSC-1980 Elk Island II

uncorrected age: 1060 ± 210

The peat sample ('Lk. Winnipeg-1973-1 (top))'; *Salix*, Cyperaceae and *Scirpus*; identified by J. Stewart) was enclosed in peat (40 cm) underlying 2.9 m wind-and water-sorted sand and gravel and

underlain by clay. The top 1.5 cm of a 3.1 m-long shelby tube sample from a borehole through the sandy barrier (tombolo) connecting Elk Island with the mainland was dated.

Comment (F. Penner): The peat is about 3 m below the long-term mean lake level and suggests that because of differential uplift between the northern end of Lake Winnipeg and the southern end, the lake level at this site has risen by about 3 m in 1060 years (about 30 cm per century).

General comments on series (F. Penner): The deposit of peat was believed to be *in situ*. GSC-1977 and -1980 may date, respectively, the earliest and latest periods when the level of Lake Winnipeg was about 3 m lower than at present due to lesser rebound of its northern outlet (cf. Penner and Swedlo, 1974). Mean lake level for the period 1920 to 1966 is 217.4 m (Geodetic).

CAMS-46194 Elk Island III

normalized age: 1420 ± 60

The 22 beggar-tick seeds (*Bidens*; identified by A.M. Telka) were enclosed in top of muddy peat between two contacts over laminated woody peat with clay laminae. Core '97301-014' was collected by D.L. Forbes and F. Jodrey on March 25, 1997, from off Elk Island in the south basin of Lake Winnipeg, Manitoba (50°44.07'N, 96°32.90'W), at an elevation of 213.4 m; water depth was 4.4 m; 0.87 m recovered from 1.26 m hammer core. This sample was submitted by D.L. Forbes to gain information on the beach foreshore, and the submergence of Lake Winnipeg.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 0.87 m sediment recovered from 1.26 m hammer core, 10 cm in diameter, taken through ice in 4.4 m water depth. The dated beggar-tick seeds (4-6 cm) were from 213.1 m asl in a muddy peat between two contacts at 0.03 and 0.10 m down-core, underlain by 41 cm-thick unit of laminated woody peat with clay-rich laminae over sharp erosional contact representing the Lake Agassiz Unconformity at 0.51 m down-core.

Comments (A.M. Telka and D.L. Forbes): This date of 1.4 ka provides a maximum age for the top of peat that began accumulating at this site about 1.8 ka (see CAMS-44531, below, p. 71). The preservational state of the dated beggar-tick seeds was excellent. The plant macrofossil assemblage from this dated interval is typical of a shoreline environment with abundant sedges (*Carex*), smartweed (*Polygonum lapathifolium*), dated beggar-ticks (*Bidens*) and a few aquatic emergents of cat-tail (*Typha*). Insect fossils were minimally represented and included mostly rove beetles (Staphylinidae), a family with varied habitats but often seen in decaying material and/or along shorelines. This date, which suggests lake levels at least 4.5 m below present, is bracketed by the top and bottom ages obtained for the nearby (or coextensive) peat deposit represented by GSC-1977 and GSC-1980. It therefore suggests more rapid lake-level change (31 cm/century) than inferred from GSC-1980.

Fossil Arthropod and Plant Macrofossil Report: 98-19 (A.M. Telka)
Sample No.: 97301-014
Interval: 4-6 cm
Laboratory No.: 3-32
Water Depth: 4.4 m
Material: muddy peat
Sample Vol.: 25 mL

PLANT MACROFOSSILS:		
Fungal Remains:		
fungal sclerotia	+	1 (large)
Non Vascular Plants:		
Bryophytes ....."mosses"		
Sphagnum sp.	+	leaves
Vascular Plants:		
Pinaceae ....."pine family"		
Larix sp.	+	needle fragment: 1
Typhaceae ....."cat-tail family"		
Typha sp.	+	seeds: 9
Gramineae ....."grass family"	+	seeds: 11
Cyperaceae ....."sedge family"	+	seed: 1 (poorly preserved)
Carex lenticular type	+	seeds: 4.5
Carex trigonous type	+	seeds: 4, half seeds: 3, seed and perigynum: 1
Salicaceae ....."willow family"		
Salix sp.	+	persistent buds: 5, twig: 1
Polygonaceae ...."buckwheat family"		
Polygonum lapathifolium type	+	seeds: 8.5
Polygonum sp.	+	seeds: 2
Rumex sp.	+	seed: 1
Cruciferae ....."mustard family"		
Rorippa islandica (Oeder) Borbas	+	seeds: 8
Rosaceae ....."rose family"		
Potentilla norvegica L.	+	seed: 1
Potentilla sp.	+	seeds: 2
Onagraceae .."evening primrose family"		
Epilobium sp. ..."willow herb"	+	seeds: 5
Umbelliferae ...."parsley family"		
Cicuta sp.	+	half seeds: 2
Labiatae ....."mint family"		
Lycopus spp.	+	seeds: 10 (two types)
Mentha sp.	+	seeds: 5.5
Compositae ...."composite family"	+	seed: 1
Bidens sp. ...."bur-marigold, beggar-ticks"	++	seeds: 22
Unidentified plant taxa	+	seed fragments: 3, seed: 1, unknown capsules: 9
Other:		
charcoal	+	fragments about 30 (some are l cm in size)
net-veined leaves	+	fragments: 10
ANIMAL MACROFOSSILS:		
ARTHROPODA		
INSECTA		
COLEOPTERA ....."beetles"	+	larval head capsule: 1, head fragment: 1, prosterna: 2
Carabidae ....."ground beetles"		
Bembidion sp.	+	head: 1, pronotum: 1 (poorly preserved)
Hydraenidae .."minute moss beetles"		
Ochthebius sp.	+	elytra: 2
Staphylinidae ..."rove beetles"		
Olophrum sp.	+	elytron: 1
Scarabaeidae ...."scarab beetles"		
Aegialia? sp.	+	elytron: 1
Helodidae ....."marsh beetles"	+	pronotum: 1, head: 1
Curculionidae ..."weevils"	+	articulated elytra with meso and metasternum: 1
TRICHOPTERA ....."caddisflies"	+	larval frontoclypeal apotome: 1
DIPTERA ....."flies"	+	puparia: 6 (two types); puparial fragments: 2
Chironomidae ...."midges"	+	larval head capsules: 8

CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	+	ephippia: 5

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 425 microns (0.425mm)

CAMS-44531 Elk Island

normalized age: 1800 ± 60

The 31 cursed crowfoot seeds (*Ranunculus sceleratus* L.; identified by A.M. Telka) were enclosed in laminated woody peat at sharp Lake Agassiz Unconformity overlying silty calcareous clay. Core '97301-014' was collected by D.L. Forbes and F. Jodrey on March 25, 1997, from off Elk Island in the south basin of Lake Winnipeg, Manitoba (50°44.07'N, 96°32.90'W), at an elevation of 213.4 m; water depth was 4.4 m; 0.87 m recovered from 1.26 m hammer core. This sample was submitted by D.L. Forbes to gain information on the onshore of Lake Winnipeg, and the submerged peat.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 0.87 m sediment recovered from 1.26 m hammer core, 10 cm in diameter, taken through ice in 4.4 m water depth. The dated cursed crowfoot seeds (48-50 cm) were from the base of a 41 cm-thick unit of laminated woody peat at a elevation of 212.7 m asl and were resting directly on sharp erosional contact representing the Lake Agassiz Unconformity at 0.51 m down-core and underlain by stiff, calcareous, silty clay.

Comments (D.L. Forbes and A.M. Telka): This date provides an age estimate for the beginning of peat accumulation at this site, immediately overlying the Lake Agassiz Unconformity, about 4.9 m below lake level at the time of sampling. The dated peat may have accumulated in a back-barrier depression similar to that inferred for GSC-1977 and GSC-1980, or may be coextensive with the peat represented by those dates. The preservational state of the dated cursed crowfoot (*Ranunculus sceleratus*) seeds was good. Fossil remains from the peat were diverse and abundant with the majority of plant macrofossil seeds being shoreline taxa. Plant remains (in order of abundance) included grasses (Gramineae), mints (*Mentha*), sedges (Cyperaceae), the dated cursed crowfoot (*Ranunculus sceleratus*), and many other taxa. Insect fossils were less diverse and included shoreline dwellers along with aquatic immature forms.

Fossil Arthropod and Plant Macrofossil Report: 98-21 (A.M. Telka)

Sample No.: 97301-014
Interval: 48-50 cm
Laboratory No.: 3-36
Water Depth: 4.4 m
Material: woody peat
Sample Vol.: 16 mL

PLANT MACROFOSSILS:		
Non Vascular Plants:		
Bryophytes ....."mosses"	+	fragments: about 10
Sphagnum sp.	+	leaves: 3
Vascular Plants:		
Typhaceae ....."cat-tail family"		
Typha sp.	+	seeds: 9
Gramineae ....."grass family"	+++	seeds: 83.5
Cyperaceae ....."sedge family"	+	seed perigynum: 2
Carex sp.	++	seeds: 28, seed and perigynum: 1
Carex trigonous type	+	seeds: 14, half seeds: 3, seed fragments: 9
Lemnaceae ....."duckweed family"		
Lemna? sp.	+	seeds: 21
Juncaceae ....."rush family"		
Juncus/Luzula ?type	+	seed: 1
Chenopodiaceae .."goosefoot family"		
Chenopodium sp.	+	seed: 1 (poorly preserved); seed fragments: 2
Caryophyllaceae? "pink family"	+	seed fragment: 1
Ranunculaceae ..."crowfoot family"		
Ranunculus sceleratus L.	++	seeds: 26
Cruciferae ....."mustard family"		
Rorippa islandica (Oeder) Borbas	+	seeds: 7.5
Rosaceae ....."rose family"		
Potentilla norvegica L.	+	seeds: 6
Potentilla sp.	+	seeds: 2 (one is poorly preserved)
Haloragaceae ...."water milfoil family"		
Hippuris sp.	+	seed: 1
Onagraceae ..."evening primrose family"		
Epilobium sp. ..."willow herb"	+	seeds: 7
Labiatae ....."mint family"		
Lycopus sp.	+	seeds: 2.5
Mentha sp.	++	seeds: 54.5
Compositae ...."composite family"	+	seed: 1
Unidentified plant taxa	+	seed: 1
Other:		
charcoal/charred wood	++	many small fragments
net-veined leaves	+	fragments: 4
ANIMAL MACROFOSSILS:		
TUBELLARIA ....."flatworms"	+	cocoons: 5
ARTHROPODA		
INSECTA		
ORTHOPTERA? .."cockroaches, grasshoppers, etc."	+	leg fragment: 1
HEMIPTERA ....."bugs"		
Saldidae ....."shore bugs"	+	head: 1, pronotal fragment: 1
COLEOPTERA ....."beetles"	+	sternites: 4, immature head capsules: 2
Staphylinidae ..."rove beetles"	+	head fragment: 1
Micropeplus tesserula? Curtis	+	elytra: 2
Omaliinae	+	head: 1
Olophrum sp.	+	elytron: 1
Helodidae ....."marsh beetles"	+	heads: 2, pronota: 2.5, elytral fragments: 5
Chrysomelidae ..."leaf beetles"	+	pronotal fragment: 1
Curculionidae ..."weevils"	+	elytral fragment: 1
DIPTERA ....."flies"	+	puparial fragments: 16
Tipulidae ....."crane flies"	+	heads: 4
Simuliidae....."black flies"	+	larval head capsule: 1
Chironomidae ...."midges"	+	larval head capsules: 10
HYMENOPTERA ....."wasps and ants"	+	thoraces: 2
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	++	ephippia: 56
ARACHNIDA		
Oribatei/Acari .."mites"	+	2
Araneae ....."spiders"	+	cephalothorax: 1, palps: 3
Unidentifiable animal taxa	+	immatures: 3
Other:		
soft-bodied insects	+	fragments: 17

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 425 microns (0.425mm)

Beta-68101 Hnausa Beach

normalized age: 170 ± 60
$\delta^{13}C$= -27.0‰
uncorrected age: 200 ± 60

The charred wood was enclosed in peat overlain by 0.2 m of pebbly organic mud. Sample 11-1f was collected by D. Currey and D. Roberts from Hnausa Beach Provincial Park on the west shore of the south basin of Lake Winnipeg, about 115 km north of Winnipeg, Manitoba (50°54'N, 96°59.5'W), at an elevation of 247 m (coordinates and elevation approximate). This sample was submitted by G.E. Tackman to gain information on the beach of Lake Winnipeg and postglacial rebound.

The calibrated age is modern with a 1 sigma range of 1670 AD to modern.

See Beta-68072 (p. 58) in the section on 'Lake Manitoba' for additional comments.

CAMS-38680 about 9 km offshore

normalized age: 4190 ± 100

The bulrush seed (*Scirpus*, identified by A.M. Telka) was enclosed in highly calcareous stiff crumbly clay immediately beneath sharp Lake Agassiz Unconformity. Core '96900 LW 221 PC' was collected by C.F.M. Lewis on September 3, 1996, from about 9 km from eastern shoreline in the south basin of Lake Winnipeg, Manitoba (50°56.1'N, 96°37.0'W), at an elevation of 217.9 m, water depth was 10.4 m, 5.78 m lake sediment recovered from 10 cm diameter piston core. This sample was submitted by C.F.M. Lewis to gain information on the Lake Agassiz Unconformity, and as a crosscheck.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 5.78 m lake sediment (5.22 m Lake Winnipeg silt-clay mud over 0.56 m Lake Agassiz calcareous clay) recovered with a 10 cm diameter by 9 m long piston corer in 10.4 m water depth. The dated bulrush seed (523-528 cm) was from crumbly zone immediately beneath sharp erosional contact representing the Lake Agassiz Unconformity, which is underlain by 40 cm of stiff, crumbly, highly calcareous clay over stiff, non-crumbly, calcareous clay extending to base of core. The sample elevation is based on acoustic profile and seismic reflection travel time to the Lake Agassiz Unconformity (Lewis et al., 2000).

Comments (D.L. Forbes and A.M. Telka): This and an associated date on a pelecypod bivalve from the same interval (see CAMS-35616, below) are interpreted to indicate an age of about 4.2 ka for initial flooding over the former subaerial surface represented by the Lake Agassiz Unconformity at this site and the beginning of lake sedimentation in the south basin (Lewis et al., 2000). The preservational state of the dated bulrush seed is fair.

CAMS-35616 about 9 km offshore

normalized age: 4320 ± 50

The freshwater pelecypod shell, in growth position, (*Sphaerium striatinum* Lamarck) was enclosed in highly calcareous stiff crumbly clay immediately beneath sharp Lake Agassiz Unconformity. Core '96900 LW 221 PC' was collected by C.F.M. Lewis on September 3, 1996, from about 9 km from the eastern shoreline in the south basin of Lake Winnipeg, Manitoba (50°56.1'N, 96°37.0'W), at an elevation of 217.9 m; water depth was 10.4 m; 5.78 m lake sediment recovered from 10 cm diameter piston core. This sample was submitted by C.F.M. Lewis to gain information on the Lake Agassiz Unconformity, and provide a crosscheck.

Assuming a $\delta^{13}C$ of -7‰, the age was normalized to a $\delta^{13}C$ of -25‰.

Stratigraphy: 5.78 m lake sediment (5.22 m Lake Winnipeg silt-clay mud over 0.56 m Lake Agassiz calcareous clay) recovered with a 10 cm diameter by 9 m long piston corer in 10.4 m water depth. The dated shell (collected in growth position; 526-527 cm) was from immediately beneath a sharp erosional contact representing the Lake Agassiz Unconformity, which is underlain by 40 cm of stiff, crumbly, highly calcareous clay over stiff, non-crumbly, calcareous clay extending to base of core. The sample elevation of 201.0 m asl is based on acoustic profile and seismic reflection travel time to the Lake Agassiz Unconformity (Lewis et al., 2000).

Comments (D.L. Forbes and A.M. Telka): This and an associated date on a *Scirpus* seed (CAMS-38680) are interpreted to indicate an age of about 4.2 ka for initial flooding over the former sub-aerial surface represented by the Lake Agassiz Unconformity at this site and the approximate age for a climate shift to wetter conditions enabling development of the lake in the south basin (Lewis et al., 2000). The preservational state of the pelecypod shell was excellent. This shell was chosen for AMS dating for comparison with the associated date on terrestrial plant material (*Scirpus* seed). The shell date of 4.3 ka is about 0.13 ka older, suggesting a 'hard-water' correction of at least 100 years.

Fossil Arthropod and Plant Macrofossil Report: 97-12 (A.M. Telka)
Sample No.: 96900 Lake Winnipeg Core 221
Interval: 523-528 cm below water sediment interface
Laboratory No.: 2-85
Water Depth: 10.4 m
Material: highly calcareous stiff crumbly clay
Sample Vol.: 85 mL (wet)

PLANT MACROFOSSILS		
Vascular Plants		
Cyperaceae "sedge family"		
Scirpus sp	+	seed: 1
Other		
net-veined leaves	+	fragment: 1
charred 'slivers'	+	about 5-10
ANIMAL MACROFOSSILS		
BRYOZOA	+	statoblasts: 8, some attached to shell
ARTHROPODA		
INSECTA		
EPHEMEROPTERA "mayflies"	+	larval mandibles: 3
DIPTERA "flies"		
Chironomidae "midges"		
Tanypodinae	+	larval head capsules: 2
CRUSTACEA		
Cladocera "water fleas"		
Daphnia sp	+	ephippia: 17
Ostracoda "ostracodes"	+	valve: 1
MOLLUSCA		
Gastropoda "snails, limpets"	+	2
Pelecypoda "clams, mussels"	++	valves: many including fragments
Other		
periostracum	++	large and small fragments

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 250 microns (0.25 mm)

CAMS-46188 Hecla Island

normalized age: 4710 ± 50

The bulrush seed (*Scirpus*; identified by A.M. Telka) was enclosed in basal, calcareous silty clay directly below Lake Agassiz Unconformity under silty clay. Core '96900 LW 222 PC' was collected by C.F.M. Lewis on September 3, 1996, from south of Hecla Island in the northern part of the south basin of Lake Winnipeg, Manitoba (50°56.1'N, 96°44.2'W), at an elevation of 217.9 m; water depth was 10.4 m; 7.86 m lake sediment recovered from 10 cm diameter piston core. This sample was submitted by C.F.M. Lewis to gain information on lake level change, and the initiation of Lake Winnipeg sedimentation.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 7.86 m lake sediment (7.35 m Lake Winnipeg clay and silty clay mud over 0.51 m Lake Agassiz silty clay) recovered with a 10 cm diameter by 9 m long piston corer in 10.4 m water depth. The dated bulrush seed (735-740 cm) lay directly below Lake Agassiz Unconformity in stiff, crumbly, calcareous silty clay. The sample elevation of 200.0 m asl is based on acoustic profile and seismic reflection travel time to the Lake Agassiz Unconformity (Lewis et al., 2000).

Comments (D.L. Forbes and A.M. Telka): This date of 4.7 ka on a bulrush (*Scirpus*) seed within crumbly zone of sediment below the Lake Agassiz Unconformity provides one of the oldest age estimates for the onset of marsh or shallow lake sedimentation in the northern south basin of Lake Winnipeg. It is probable that the sample post-dates the Lake Agassiz Unconformity, but was introduced into the underlying Lake Agassiz silty clay through fractures in the subaerial or shallow subaqueous surface (see BGS-1477, p. 60). The preservational state of the dated bulrush seed was fair.

Fossil Arthropod and Plant Macrofossil Report: 98-37 (A.M. Telka)
Sample No.: 96900 Lake Winnipeg Core 222
Interval: 735-740 cm below water sediment interface
Laboratory No.: 2-90
Water Depth: 10.4 m
Material: calcareous silty clay
Sample Vol.: 90 mL (wet)

PLANT MACROFOSSILS		
Vascular Plants		
Typhaceae ....."cat-tail family"		
Typha sp.	+	seed: 1
Potamogetonaceae ."pondweed family"		
Zanichellia palustris L.	+	seed: 1
Cyperaceae ....."sedge family"		
Scirpus sp.	+	seeds: 6, seed fragments: 3
Polygonaceae ...."buckwheat family"		
Rumex sp.	+	seed: 1
Chenopodiaceae ."goosefoot family"		
Chenopodium sp.	+	seed: 1
Other:		
charcoal	+	fragments: 4
ANIMAL MACROFOSSILS		
ARTHROPODA		
INSECTA		
COLEOPTERA ....."beetles"	+	articulated tibia and femur: 1
Hydrophilidae ..."water scavenger beetles"	+	elytral fragments: 3
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	+	ephippia: 2
Ostracoda ....."ostracodes"	+	valves: 6
MOLLUSCA		
Gastropoda ....."snails, limpets"	+	1
Pelecypoda ....."clams, mussels"	+	intact valves: 1, valve: 1, fragments: 19
Other:		
bone	+	2 (one is about 1 cm long)

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 425 microns (0.425mm)

CAMS-35494 'Pearson Reef'

normalized age: 1970 ± 170

The terrestrial beetle parts (*Amara, Agonum* and *Hypera*; identified by A.M. Telka) were 67 cm above the base of interbedded coarse pebbly sand and silty clay under clay mud. Core '96900 LW 219 PC' was collected by C.F.M. Lewis on August 29, 1996, from 'Pearson Reef' in the south basin of Lake Winnipeg, Manitoba (50°56.6'N, 96°41.0'W), at an elevation of 217.8 m; water depth was 10.5 m; 4.39 m lake sediment recovered from 10 cm diameter piston core. This sample was submitted by C.F.M. Lewis to gain information on the beach (lagoon) of Lake Winnipeg, and 'Pearson Reef' paleobeach and lagoon.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 4.39 m lake sediment (1.65 m of Lake Winnipeg clay mud over 0.93 m fine to medium sand with granules, rare pebbles, and mud interbeds over 1.81 m of interbedded coarse pebbly sand and silty clay mud) recovered with a 10 cm diameter by 9 m long piston corer in 10.5 m water depth. The dated insects (372-377 cm) were about 2.07 m below the top of the sand. The sample elevation of 203.0 m asl is based on acoustic profile and seismic reflection travel time to the top of sand (Lewis et al., 2000).

Comments (D.L. Forbes and A.M. Telka): This date was intended to provide an age for infilling of a small basin interpreted as a back-barrier lagoon behind the former spit along the east side of 'Pearson Reef' shoal. The pebbly sand in the core is interpreted as barrier washover sediment interbedded with finer deposits accumulating between washover events. The preservational state of dated insect fossils was excellent. Insect fossils were abundant and well preserved in this assemblage and included fragile 'articulated' beetles (i.e. with body parts attached). Plant macrofossils were rare with only five cat-tail (*Typha*) seeds and one goosefoot (*Chenopodium*) seed. The relatively high number of insect fossils in this assemblage constitutes a marked taphonomic bias. It is unusual to find so few plant macrofossils in association with such a diverse insect assemblage. Because the insect fossils are well preserved and do not contain pitted or worn surfaces, it can be assumed that these fossils were deposited in a subaqueous environment (e.g. flushed from a nearby source and quickly deposited in sand). The age of 2.0 ka is younger than other dates obtained for the relict beach system at 'Pearson Reef', suggesting either continued growth of the spit as lake level rose (the adjacent barrier crest elevation is 205.9 m or 11.9 m below present mean lake level) or later reworking of the submerged spit shoal, such that the back-barrier lagoon fill is much younger than the spit and may include contributions of material from nearby higher shoreline sources.

Fossil Arthropod and Plant Macrofossil Report: 97-09 (A.M. Telka)
Sample No.: 96900 Lake Winnipeg Core 219
Interval: 372-377 cm below water sediment interface
Laboratory No.: 2-31
Water Depth: 10.5 m
Material: mud and sand
Sample Vol.: 80 mL (wet)

PLANT MACROFOSSILS:		
Vascular Plants:		
Typhaceae ....."cat-tail family"		
Typha sp.	+	seeds: 5
Salicaceae ....."willow family"		
Salix sp.	+	bud: 1, twigs with bark: 4
Chenopodiaceae .."goosefoot family"		
Chenopodium sp.	+	seed: 1 (well preserved with outer covering)
Other:		
twigs	+	
charcoal	+	fragment: 1
net-veined leaves	+	fragment: 1
leaf	+	1
ANIMAL MACROFOSSILS:		
PORIFERA ....."sponges"		
HAPLOSCLERINA		
Spongillidae		
Spongilla type	++	colonies, single cell
ARTHROPODA		
INSECTA	+	mandible: 1
EPHEMEROPTERA ..."mayflies"	+	larval mandibles: 3
Saldidae ....."shore bugs"		
Saldula sp.	+	pronota: 2
HOMOPTERA		
Cicadellidae ...."leafhoppers"	+	head: 1
COLEOPTERA ....."beetles"	+	misc fragments, elytron, pronota: 2, articulated femur and tibia, head fragment
Carabidae ....."ground beetles"	+	head: 1
Microlestes sp.	+	articulated prothorax: 1, pronotum: 1
Bembidion sp.	+	elytra: 2
Bembidion quadrimaculatum grp.	+	pronotum: 1, elytron: 1
Agonum sp.	+	elytron: 1, half elytron: 1
Amara sp.	+	elytron: 1
Selenophorus sp.	+	head: 1
Dytiscidae ....."predaceous diving beetles"	+	head: 1
Hydrophilidae ..."water scavenger beetles"	+	elytra: 3, heads: 2, elytral fragments: 2
Staphylinidae ..."rove beetles"	+	pronota: 2
Olophrum sp.	+	pronotal fragment: 1
Stenus sp.	+	elytron: 1, pronota: 2, abdomen: 1
Lathrobium sp.	+	elytron: 1
Quedini	+	pronota: 2
Histeridae ....."hister beetles"	+	head fragment: 1
Scarabaeidae ...."scarab beetles"	+	articulated femur and tibia: 2
Aphodius sp.	+	elytron: 1
Helodidae ....."marsh beetles"	+	elytra: 2, head: 1
Byrrhidae ....."pill beetles"		
Byrrhus sp.	+	half elytron: 1
Elmidae	+	elytron: 1
Elateridae ....."click beetles"	+	pronotum: 1
Lathridiidae ...."minute brown scavenger beetles"	+	articulated head and pronotum: 1
Chrysomelidae ..."leaf beetles"	+	pronotum: 1, elytral fragment: 2
Donacia sp.	+	head: 1
Alticinae ....."flea beetles"	+	head: 1
Curculionidae ..."weevils"	+	head: 1, elytral fragment with scales: 1
Hypera sp.	+	elytron: 1
TRICHOPTERA ....."caddisflies"	+	larval frontoclypeal apotomes: 5, case fragments: 4
DIPTERA ....."flies"		
Chironomidae ...."midges"	+	larval head capsules: 5
HYMENOPTERA ..."wasps and ants"	+	thoraces: 3, head:1
Formicidae ....."ants"		
Formica type	+	head: 1
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	+	ephippia: 4
Ostracoda ....."ostracodes"	+	valve: 1
ARACHNIDA		
Araneae ....."spiders"	+	cephalothorax: 1
MOLLUSCA		
Gastropoda ....."snails, limpets"	+	fragment: 1
Unidentified animal taxa	+	larval mandibles: 5
Other:		
fish vertebra	+	1
soft-bodied fragments	+	

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 250 microns (0.25 mm)

CAMS-35500 'Pearson Reef'

normalized age: 2940 ± 80

The raspberry seeds (*Rubus idaeus* L.; identified by A.M. Telka) were enclosed in base of interbedded coarse pebbly sand and silty clay mud, under clay mud. Core '96900 LW 219 PC' was collected by C.F.M. Lewis on August 29, 1996, from 'Pearson Reef' in the south basin of Lake Winnipeg, Manitoba (50°56.6'N, 96°41.0'W), at an elevation of 217.8 m; water depth was 10.5 m; 4.39 m lake sediment recovered from 10 cm diameter piston core. This sample was submitted by C.F.M. Lewis to gain information on the beach (lagoon) of Lake Winnipeg, and 'Pearson Reef' paleobeach and lagoon.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 4.39 m lake sediment (1.65 m of Lake Winnipeg clay mud over 0.93 m fine to medium sand with granules, rare pebbles, and mud interbeds over 1.81 m of interbedded coarse pebbly sand and silty clay mud) recovered with a 10 cm diameter by 9 m long piston corer in 10.5 m water depth. The dated raspberry seeds (436-439 cm) were from the base of the core, 2.74 m below the top of the sand. The sample elevation of 202.3 m asl is based on acoustic profile and seismic reflection travel time to the top of sand (Lewis et al., 2000).

Comments (D.L. Forbes and A.M. Telka): This date was intended to provide an age for infilling of a small basin interpreted as a back-barrier lagoon behind the former spit along the east side of 'Pearson Reef' shoal. The pebbly sand in the core is interpreted as barrier washover sediment interbedded with finer deposits accumulating between washover events. The preservational state of dated raspberry (*Rubus idaeus*) seed and fragments was poor. The plant macrofossil assemblage comprised mostly *Potentilla paradoxa* Nutt and goosefoot seeds (*Chenopodium*) as well as a few other shoreline inhabitants. The insect fossil assemblage was more varied with both aquatic species (e.g. water strider (Gerridae) and predaceous diving beetles (Dytiscidae)) and many shoreline types. The combined macrofossil evidence suggests that the shoreline was near the core site, consistent with the seismic reflection profile interpretation and core lithology. The age of 2.9 ka is older than the 2.0 ka insect assemblage 70 cm higher in the core (CAMS-35494) and between 0.1 and 1.0 ka younger than other dates obtained for the relict beach system at 'Pearson Reef' (CAMS-32190 and CAMS-35495;

Note that the older age for CAMS-32193 incorporates a reservoir error), suggesting that the 'Pearson Reef' spit developed between 3.9 and 2.9 ka.

Fossil Arthropod and Plant Macrofossil Report: 97-10 (A.M. Telka)
Sample No.: 96900 Lake Winnipeg Core 219
Interval: 436-439 cm below water sediment interface
Laboratory No.: 2-31.5
Water Depth: 10.5 m
Material: Lake sediment from 4.39 m long, 10 cm wide piston core.
Sample Vol.: 80 mL (wet)

PLANT MACROFOSSILS:		
Fungal Remains:		
fungal sclerotia	+	10
Non Vascular Plants:		
Bryophytes ....."mosses"	+	fragments: 2 with leaves
Vascular Plants:		
Cyperaceae ....."sedge family"	+	inflorescence scales(bud): 2
Scirpus sp.	+	seed: 1
Polygonaceae ...."buckwheat family"		
Rumex sp.	+	seed: 1, calyx: 1
Chenopodiaceae .."goosefoot family"		
Chenopodium spp.	+	seeds: 4, halves: 5, fragments: 10
Rosaceae ....."rose family"		
Potentilla sp.	+	seeds: 3
Potentilla paradoxa Nutt.	++	seeds: 14.5
Rubus idaeus L.	+	seeds: 1, halves: 2, fragment: 1
Prunus? sp.	+	half seed: 1
Unidentified plant taxa	+	half seeds: 2
Other:		
wood and twigs	+	twigs: with and without bark, wood fragments: 'rounded' ends and no bark
net-veined leaves	+	fragments: 4
bark	+	fragment: 1
ANIMAL MACROFOSSILS:		
PORIFERA ....."sponges"		
HAPLOSCLERINA		
Spongillidae		
Spongilla type	+	colony 'mats': 14
ARTHROPODA		
INSECTA		
EPHEMEROPTERA ..."mayflies"	+	larval mandible: 1
HEMIPTERA ....."bugs"	+	head fragment
Gerridae ....."water striders"		
Gerris sp.	+	thorax: 1
COLEOPTERA ....."beetles"	+	larval head: 1, pronotum: 1, elytral fragment: 1
Carabidae ....."ground beetles"		
Microlestes sp	+	half elytron: 1
Bembidion sp.	+	elytron: 1
Agonum? sp.	+	elytron: 1
Dytiscidae ....."predaceous diving beetles"	+	elytral fragment: 1
Hydrophilidae .."water scavenger beetles"	+	elytra: 2, fragments: 1, pronotum: 1
Cercyon sp.	+	elytron: 1
Hydraenidae ....."minute moss beetles"		
Ochthebius sp.	+	half elytron: 1
Staphylinidae ..."rove beetles"	+	elytra: 3, mesosternum: 1
Quedini	+	pronota: 2
Leiodidae? .."round fungus beetles"	+	elytron: 1
Scaphiidae? .."shining fungus beetles"	+	elytron: 1
Helodidae ....."marsh beetles"	+	head: 1
Cyphon sp.	+	elytron: 1
Curculionidae ..."weevils"	+	elytron: 1
Ceutorhynchus sp.	+	elytron: 1
TRICHOPTERA ....."caddisflies"	+	larval frontoclypeal apotomes: 4
DIPTERA ....."flies"	+	thorax: 1
HYMENOPTERA ..."wasps and ants"	+	head: 1
Formicidae ....."ants"	+	heads: 1.5
ARACHNIDA		
Araneae ....."spiders"	+	cephalothorax: 1
Unidentifiable animal taxa	+	large chitinous pupal case, cocoons: 3
Other:		
bone	+	fragment: 1
feces	+	fragments: 2
soft-bodied (immature) insects	+	fragments-misc.

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 250 microns (0.25 mm)

CAMS-32190 'Pearson Reef'

normalized age: 3060 ± 70

The twig (unidentifiable wood) was enclosed in silt-clay mud with bioturbated? fine sand lenses over fine and medium sand. Core '94900 LW 115 GC' was collected by C.F.M. Lewis on August 26, 1994, from about 5 km off Hecla Island ('Pearson Reef') in the south basin of Lake Winnipeg, Manitoba (50°56.76'N, 96°40.90'W), at an elevation of 217.9 m; water depth was 10.7 m; 2.76 m lake sediment recovered from 6 cm diameter gravity core. This sample was submitted by C.F.M. Lewis to gain information on lake level change, and 'Pearson Reef' paleobeach and shoreface.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 2.76 m lake sediment recovered with a 6 cm diameter by 9 m long gravity corer in 10.7 m water depth. The dated twig (256-263 cm) was from basal Lake Winnipeg silt-clay mud with bioturbated? fine sand lenses, 5 to 12 cm above the contact with underlying fine and medium sand. The sample elevation of 202.4 m asl is based on acoustic profile and seismic reflection travel time to the top of sand (Lewis et al., 2000).

Comments (A.M. Telka and C.F.M. Lewis): The preservation of the twig was good with bark intact, indicating minimal transport prior to final deposition. Wood and twigs in various states of preservation were abundant in this sample. Plant macrofossils were represented by a few sedges (*Carex*) and goosefoot (*Chenopodium*) seeds. Insect remains were relatively abundant with both terrestrial and aquatic components. Shoreline type insects such as shore bugs (*Saldula*) and marsh beetles (Helodidae) dominated the assemblage. An age of 3.1 ka is suggested for the paleobeach at 'Pearson Reef'.

Fossil Arthropod and Plant Macrofossil Report: 96-23 (A.M. Telka)
Sample No.: 94900 Lake Winnipeg Core 115
Interval: 256-263 cm below water sediment interface
Laboratory No.: 1-127
Water Depth: 10.7 m
Material: silt-clay mud
Sample Vol.: 36 mL (wet)

PLANT MACROFOSSILS:		
Fungal Remains:		
fungal sclerotia	+	1
Vascular Plants:		
Cyperaceae ....."sedge family"		

Carex trigonous type	+	fragments: 2
Salicaceae ....."willow family"		
Salix sp.	+	twig fragments
Chenopodiaceae .."goosefoot family"		
Chenopodium sp.	+	seed: 1
Unidentified plant taxa	+	capsule?
Other:		
wood	+	numerous frags with and without bark, twigs
net-veined leaf	+	fragments
ANIMAL MACROFOSSILS:		
PORIFERA ....."sponges"		
HAPLOSCLERINA		
Spongillidae		
Spongilla type	+	colony 'mats': 3
ARTHROPODA		
INSECTA		
EPHEMEROPTERA ..."mayflies"	+	larval mandibles: few
HEMIPTERA ....."bugs"		
Saldidae ....."shore bugs"		
Saldula type	+	pronotum: 1
COLEOPTERA ....."beetles"		
Carabidae ....."ground beetles"		
Bembidion sp.	+	elytron: 1
Bembidion quadrimaculata grp.	+	pronotum: 1
Gyrinidae ....."whirligig beetles"	+	half elytron: 1
Hydrophilidae ..."water scavenger beetles"	+	half elytron: 1
Staphylinidae ..."rove beetles"		
Quedini	+	pronotum: 1, head: 1
Aleocharinae	+	elytron: 1
Helodidae ....."marsh beetles"	+	half elytron: 1
TRICHOPTERA ....."caddisflies"	+	larval frontoclypeal apotomes (2 types): 2
DIPTERA ....."flies"	+	puparial fragments (2 types): 2
Chironomidae ...."midges"	++	larval head capsules: 10
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	+	ephippia: few
ARACHNIDA		
Oribatei/Acari .."mites"	+	2
Other:		
bone?	+	fragment: 1

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 250 microns (0.25 mm)

Comments: This sample contains the greatest amount of organic material compared to all other samples examined in the Lake Winnipeg cores.

CAMS-46193 'Pearson Reef'

normalized age: 3870 ± 140

The water-smartweed seed (*Polygonum amphibium* L.; identified by A.M. Telka) was enclosed in noncalcareous silty clay mud directly above sharp contact over fine calcareous sand. Core '96900 LW 220 PC' was collected by C.F.M. Lewis on August 29, 1996, from 'Pearson Reef' in the south basin of Lake Winnipeg, Manitoba (50°56.8'N, 96°40.9'W), at an elevation of 217.8 m; water depth was 10.5 m; 5.53 m lake sediment recovered from 10 cm diameter piston core. This sample was submitted by C.F.M. Lewis to gain information on the offshore beach shoreface of Lake Winnipeg, and document the onset of mud sedimentation over 'Pearson Reef'.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 5.53 m Lake Winnipeg sediment (4.07 m clay and silty clay mud with occasional sand interbeds over 1.46 m sand and gravel) recovered with a 10 cm diameter by 9 m long piston corer in 10.5 m water depth. The dated water-smartweed seed (395-400 cm) was from near the base of noncalcareous silty clay mud 7 to 12 cm above sharp contact underlain by fine calcareous sand with granules and occasional medium sand and pebbly gravel. The sample elevation of 202.7 m asl is based on acoustic profile and seismic reflection travel time to the top of sand (Lewis et al., 2000).

Comments (D.L. Forbes and A.M. Telka): This date provides an age estimate of 3.9 ka for flooding of the former shore zone at 'Pearson Reef' under rising lake levels and the beginning of mud deposition over the sand. The preservational state of the dated water-smartweed (*Polygonum amphibium* L.) seed was excellent.

Fossil Arthropod and Plant Macrofossil Report: 98-36 (A.M. Telka)
Sample No.: 96900 Lake Winnipeg Core 220
Interval: 395-400 cm below water sediment interface
Laboratory No.: 2-103
Water Depth: 10.5 m
Material: noncalcareous silty clay mud
Sample Vol.: 85 mL (wet)

PLANT MACROFOSSILS:		
Fungal Remains:		
fungal sclerotia	+	7
Non Vascular Plants:		
Bryophytes ....."mosses"	+	stem with leaves: 1
Vascular Plants:		
Cyperaceae ....."sedge family"		
Scirpus sp.	+	seed: 1
Polygonaceae ...."buckwheat family"		
Rumex sp.	+	seed with calyx: 1
Polygonum/Rumex type	+	seed: 1
Polygonm amphibium L.	+	seed: 1
Chenopodiaceae .."goosefoot family"		
Chenopodium sp.	+	seed fragments: 5
Other:		
wood	+	larger piece: 'angular ends'
twigs	+	small fragments: with/without bark
net-veined leaf	++	fragments: many, (not counted)
ANIMAL MACROFOSSILS:		
PORIFERA ....."sponges"		
HAPLOSCLERINA		
Spongillidae		
Spongilla type	+	4-cell clusters: 4
ARTHROPODA		
INSECTA		
EPHEMEROPTERA ..."mayflies"	+	mandibles: 7
HEMIPTERA ....."bugs"	+	wing fragment: 1, head: 1
Corixidae ....."water boatmen"	+	hemelytral fragments: 4
HOMOPTERA		
Cicadellidae ...."leafhoppers"	+	head: 1
COLEOPTERA ....."beetles"	+	misc.: sternites: 3, legs: 2, metasternum: 1, elytron: 1, prosternum: 1
Dytiscidae ... "predaceous diving beetles"	+	elytral fragment: 1
Hydrophilidae ..."water scavenger beetles"	+	elytral fragment: 1
Hydraenidae .."minute moss beetles"		
Ochthebius sp.	+	elytron: 1, articulated pronotum: 1

Staphylinidae ..."rove beetles"	+	head fragment: 1, elytron: 1
Lathrobium type	+	elytron: 1
Quedini	+	head: 1
Helodidae ....."marsh beetles"	+	elytral fragment: 1, pronota: 2.5
Lathridiidae ...."minute brown scavenger beetles"	+	elytron: 1
Chrysomelidae ..."leaf beetles"	+	pronotal fragment: 1, elytral fragments: 4
TRICHOPTERA ....."caddisflies"	+	larval: case fragment: 1, frontoclypeal apotomes: 2
DIPTERA ....."flies"	+	thoraces: 4
Chironomidae ...."midges"	+	larval head capsules: 10
HYMENOPTERA ....."wasps and ants"		
Ichneumonoidea .."ichneumons and braconids"		
Ichneumonidae	+	thorax: 1
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	+	ephippia: 44
Ostracoda ....."ostracodes"	+	valves: 2
ARACHNIDA		
Oribatei/Acari .."mites"	+	half: 1
Araneae ....."spiders"	+	palp: 1
Unidentifiable animal taxa	+	mandibles: 3
Other:		
iron pyrite	++	
egg cases	+	7

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 250 microns (0.25 mm)

CAMS-35495 'Pearson Reef'

normalized age: 3920 ± 70

The 5 goosefoot seeds (*Chenopodium*; identified by A.M. Telka) were 13 cm above the base of a calcareous sand unit underlying silty clay mud. Core '96900 LW 220 PC' was collected by C.F.M. Lewis on August 29, 1996, from 'Pearson Reef' in the south basin of Lake Winnipeg, Manitoba (50°56.8'N, 96°40.9'W), at an elevation of 217.8 m; water depth was 10.5 m; 5.53 m lake sediment recovered from 10 cm diameter piston core. This sample was submitted by C.F.M. Lewis to gain information on the offshore beach shoreface of Lake Winnipeg, and 'Pearson Reef' paleo-shoreface; as well as a crosscheck.

Assuming a $\delta^{13}C$ of -27‰, the age was normalized to a $\delta^{13}C$ of -25‰.

Stratigraphy: 5.53 m Lake Winnipeg sediment (4.07 m clay and silty clay mud with occasional sand interbeds over 1.46 m sand and gravel) recovered with a 10 cm diameter by 9 m long piston corer in 10.5 m water depth. The dated goosefoot seeds (535-540 cm) were 1.33 m below the top of fine calcareous sand with granules and occasional medium sand and pebbly gravel, overlain above sharp contact by 4.07 m of clay mud and silty clay mud with one 9 cm sand bed and other rare thin sand beds and inclusions. The sample elevation of 201.3 m asl is based on acoustic profile and seismic reflection travel time to the top of sand (Lewis et al., 2000).

Comments (A.M. Telka and C.F.M. Lewis): The dated goosefoot seeds were well preserved compared to the remaining macrofossils and organics within this sample, which contain pitted surfaces. Insect fossils were rare but mollusc fragments were abundant. This date of 3.9 ka provides an age estimate for shoreface sediments associated with the former beach at 'Pearson Reef'.

Fossil Arthropod and Plant Macrofossil Report: 97-11 (A.M. Telka)
Sample No.: 96900 Lake Winnipeg Core 220
Interval: 535-540 cm below water sediment interface
Laboratory No.: 2-34
Water Depth: 10.5 m
Material: calcareous sand
Sample Vol.: 80 mL (wet)

PLANT MACROFOSSILS:		
Fungal Remains:		
fungal sclerotia	+	1
Vascular Plants:		
Cyperaceae ....."sedge family"		
Scirpus? sp.	+	seed fragment: 1
Chenopodiaceae .."goosefoot family"		
Chenopodium sp.	+	seeds: 5, half seeds: 4
Rosaceae ....."rose family"		
Prunus sp.	+	half seed: 1
Other:		
bark	+	many fragments, curled pieces
wood	+	few fragments, all are very worn with 'pitted' surfaces, charred fragments: 2
twigs	+	charred fragment: 1 'fire hardened' fragment:1, twig with bark: 1
ANIMAL MACROFOSSILS:		
ARTHROPODA		
INSECTA		
DIPTERA ....."flies"		
Chironomidae ...."midges"	+	larval head capsule: 0.5
CRUSTACEA		
Ostracoda ....."ostracodes"	+	valves: 3
ARACHNIDA		
Oribatei/Acari .."mites"	+	1
MOLLUSCA		
Gastropoda ....."snails, limpets"	+	3
Pelecypoda ....."clams, mussels"	+	valve: 1, fragments: many large and small, including some with periostracum
Unidentifiable animal taxa	+	puparial fragment: 1
Other:		
bone	+	fragment: 1
modern contaminant	+	fly abdomen

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 250 microns (0.25 mm)

CAMS-32193 'Pearson Reef'

normalized age: 4760 ± 70

The freshwater pelecypod shell, whole valve (unidentifiable according to C.G. Rodrigues) was enclosed in calcareous sand overlain by Lake Winnipeg silty clay mud. Core '96900 LW 220 PC' was collected by C.F.M. Lewis on August 29, 1996, from 'Pearson Reef' in the south basin of Lake Winnipeg, Manitoba (50°56.8'N, 96°40.9'W), at an elevation of 217.8 m; water depth was 10.5 m; 5.53 m lake sediment recovered from 10 cm diameter piston core. This sample was submitted by C.F.M. Lewis to gain information on the offshore beach shoreface of Lake Winnipeg, and the 'Pearson Reef' paleo-shoreface; as well as a crosscheck.

Assuming a $\delta^{13}C$ of -7‰, the age was normalized to a $\delta^{13}C$ of -25‰.

Stratigraphy: 5.53 m Lake Winnipeg sediment (4.07 m clay and silty clay mud with occasional sand interbeds over 1.46 m sand and gravel) recovered with a 10 cm diameter by 9 m long piston corer in 10.5 m water depth. The dated shell (542-547 cm) was from near base of core in fine calcareous sand with granules and occasional medium sand and pebbly gravel. The sample elevation of 201.5 m asl is based on acoustic profile and seismic reflection travel time to the top of sand (Lewis et al., 2000).

Comments (C.F.M. Lewis and D.L. Forbes): This dated mollusc and associated dates indicate that an aqueous environment existed at this site several hundred years before deposition of the former beach at 'Pearson Reef'. This beach, at about 14 m below present mean lake level, developed circa 4 ka, after which it was abandoned by rising lake levels and buried by deposition of suspended mud in the deeper lake.

Comment (A. Telka): This shell was chosen for AMS dating for a comparison between dating upland shoreline terrestrial plant taxa (see CAMS-35495, p. 77) and molluscs. The shell date of 4.8 ka is about 0.84 ka older than the corresponding dated goosefoot seeds (3.9 ka) providing a 'hardwater' correction of about 840 years.

CAMS-44529 Sandy Bar, Hecla Island

normalized age: 1850 ± 50

The bulrush seed (*Scirpus*; identified by A.M. Telka) was enclosed in calcareous silty sand, 3 cm above Lake Agassiz Unconformity overlying firm silty clay. Core '97301-010' was collected by D.L. Forbes, L. Hopkinson and F. Jodrey on March 24, 1997, from off Sandy Bar, Hecla Island, in the northern part of the south basin of Lake Winnipeg, Manitoba (51°00.22'N, 96°52.24'W), at an elevation of 214.3 m; water depth was 3.4 m; 0.74 m recovered from 1.18 m hammer core. This sample was submitted by D.L. Forbes to gain information on the onshore beach, and shoreface deposition in the northern south basin.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 0.74 m sediment recovered from 1.18 m hammer core, 10 cm in diameter, taken through ice in 3.4 m water depth. The dated bulrush seed (49-51 cm) was from near the base of a 52 cm-thick unit of ripple-laminated, calcareous, silty sand, about 3 cm above erosional contact representing the Lake Agassiz Unconformity, which is underlain by firm silty clay.

Comments (D.L. Forbes and A.M. Telka): This sample provides an age on the deposition of parallel- and ripple cross-laminated silty sand about 3.9 m below present lake level, overlying the Lake Agassiz Unconformity. The preservational state of the dated bulrush (*Scirpus*) seed was fair retaining some vulnerable surface features. Plant and insect macrofossils were minimally represented and contain a few seeds of aquatic emergents, bulrushes and sedges as well as immature forms of aquatic insects.

Fossil Arthropod and Plant Macrofossil Report: 98-14 (A.M. Telka)
Sample No.: 97301-010
Interval: 49-51 cm
Laboratory No.: 3-25
Water Depth: 3.4 m
Material: silty sand with organics
Sample Vol.: 12 mL

PLANT MACROFOSSILS:		
Non Vascular Plants:		
Bryophytes ....."mosses"	+	leaves: 2
Vascular Plants:		
Typhaceae ....."cat-tail family"		
Typha sp.	+	seed: 1
Potamogetonaceae .."pondweed family"		
Zanichellia palustris L.	+	seeds: 2
Alismaceae ...."water plantain family"		
Sagittaria sp.	+	seed embryo: 1
Cyperaceae ....."sedge family"	+	seed perigynum: 1
Carex trigonous type	+	seed: 1
Scirpus sp.	+	large seeds: 4 (poorly preserved)
Chenopodiaceae .."goosefoot family"		
Chenopodium spp.	+	seeds: 2, seed fragment: 1
Rosaceae ....."rose family"		
Potentilla ?sp.	+	seed: 1 (poorly preserved)
Unidentified plant taxa	+	seed fragment: 1
Other:		
wood	+	few fragments, without bark
net-veined leaves	+	fragments: 2
ANIMAL MACROFOSSILS:		
PORIFERA ....."sponges"		
HAPLOSCLERINA		
Spongillidae		
Spongilla type	+	single cell: 2, colony 'mat': 1
TUBELLARIA ....."flatworms"	+	cocoons: 3
ARTHROPODA		
INSECTA		
EPHEMEROPTERA ..."mayflies"	+	larval mandibles: 2
COLEOPTERA ....."beetles"		
Staphylinidae ..."rove beetles"		
Aleocharinae	+	elytron: 1
DIPTERA ....."flies"		
Chironomidae ...."midges"	+	larval head capsules: 2
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	+	ephippia: 2
Ostracoda ....."ostracodes"	+	valves: 2
MOLLUSCA		
Gastropoda ....."snails, limpets"	+	whole: 2, fragments: 4
Unidentifiable animal taxa	+	egg cases: 2

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 250 microns (0.25 mm)

CAMS-46189 Sandy Bar, Hecla Island

normalized age: 2190 ± 50

The bulrush seed (*Scirpus*; identified by A.M. Telka) was enclosed in calcareous silty sand, 41 cm above Lake Agassiz Unconformity overlying silty clay. Core '97301-010' was collected by D.L. Forbes, L. Hopkinson and F. Jodrey on March 24, 1997, from off Sandy Bar, Hecla Island, in the northern part of the south basin of Lake Winnipeg, Manitoba (51°00.22'N, 96°52.24'W), at an elevation of 217.7 m; water depth was 3.4 m; 0.74 m recovered from 1.18 m hammer core. This sample was submitted by D.L. Forbes to gain information on the beach foreshore of Lake Winnipeg, and shoreface deposition.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 0.74 m sediment recovered from 1.18 m hammer core, 10 cm in diameter, taken through ice in 3.4 m water depth. The dated bulrush seed (13 cm) at an elevation of 214.2 m asl was from a 52 cm-thick unit of ripple-laminated, calcareous, silty sand, about

41 cm above erosional contact representing the Lake Agassiz Unconformity, which is underlain by firm silty clay.

Comments (D.L. Forbes and A.M. Telka): This sample dates shoreface deposition as described for CAMS-44529. The older age of this sample, 37 cm higher in the core than CAMS-44529, indicates that organics in this facies were reworked by storm waves and currents and were presumably derived from shoreline deposits nearby. The preservational state of the dated bulrush (*Scirpus*) seed was poor (no basal filaments attached, seed tip worn showing signs of mechanical abrasion). Macrofossil seeds and insect fossil remains, representing mostly shoreline indicators with a few aquatic taxa, were fragmented with very few complete.

Fossil Arthropod and Plant Macrofossil Report: 98-12 (A.M. Telka)
Sample No.: 97301-010
Interval: 13 cm
Laboratory No.: 3-23
Water Depth: 3.4 m
Material: silty sand with organics
Sample Vol.: 5 mL

PLANT MACROFOSSILS:		
Fungal Remains:		
fungal sclerotia	+	4
Vascular Plants:		
Typhaceae ....."cat-tail family"		
Typha sp.	+	seeds: 5
Potamogetonaceae .."pondweed family"		
Zanichellia palustris L.	+	seeds: 4
Alismaceae ....."water plantain family"		
Sagittaria sp.	+	seeds: 3
Gramineae ....."grass family"	+	seed: 1
Cyperaceae ....."sedge family"		
Carex spp.	+	seeds: 13, fragments: 8, seed with perigynum: 1
Carex lenticular type	+	seeds: 6
Eleocharis sp.	+	seeds: 2, half seed: 1
Scirpus sp.	+	seeds: 2, seed fragments: 2
Betulaceae ....."birch family"		
Betula sp.	+	seed: 1 (partial wing)
Polygonaceae ...."buckwheat family"		
Polygonum lapathifolium type	+	seeds: 1.5
Rumex sp.	+	seed: 1
Chenopodiaceae .."goosefoot family"		
Chenopodium sp.	+	half seeds: 2, seed fragments: 2
Ranunculaceae ..."crowfoot family"		
Ranunculus sceleratus type	+	seeds: 5, half seeds: 2
Ranunculus trichophyllus type	+	seed: 1
Cruciferae ....."mustard family"		
Rorippa islandica (Oeder) Borbas	+	seed: 1
Rosaceae ....."rose family"		
Potentilla sp.	+	seed: 1, half seed: 1
Potentilla norvegica L.	+	half seeds: 2
Potentilla paradoxa Nutt.	+	seed: 1
Hypericaceae ...."St. John's-wort family"		
Hypericum sp.	+	seed: 1
Haloragaceae ...."water milfoil family"		
Hippuris sp.	+	seed: 1
Labiatae ....."mint family"		
Mentha sp.	+	seeds: 9
Unidentified plant taxa	+	seed: 1
Other:		
soft coal	+	fragments: 3
charcoal	+	fragments: 6
tree bud scar	+	1
net-veined leaves	+	fragments: 8

ANIMAL MACROFOSSILS:		
PORIFERA ....."sponges"		
HAPLOSCLERINA		
Spongillidae		
Spongilla type	+	4-cell clumps: 8, colony "mat": 1
ARTHROPODA		
INSECTA		
EPHEMEROPTERA ..."mayflies"	+	larval mandible: 1
COLEOPTERA ....."beetles"	+	elytral fragments: 4, larval head capsule: 1, half pronotum: 1
Carabidae ....."ground beetles"	+	prosternum: 1, elytron: 1
Bembidion sp.	+	half pronotum: 1
Hydrophilidae ..."water scavenger beetles"	+	half elytron: 1
Staphylinidae ..."rove beetles"	+	metasternum: 1
Olophrum sp.	+	elytron: 1
Aleocharinae	+	elytron: 1
Chrysomelidae ..."leaf beetles"	+	elytral fragment: 1
Curculionidae ..."weevils"	+	pronotal fragments: 2
TRICHOPTERA ....."caddisflies"	+	larval case fragment: 1
DIPTERA ....."flies"	+	puparial fragments: 4
Chironomidae ...."midges"	+	larval head capsules: 2
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	+	ephippia: 5
Ostracoda ....."ostracodes"	+	valves: 6
MOLLUSCA		
Gastropoda ....."snails, limpets"	+	whole: 3, fragments:3
Pelecypoda ....."clams, mussels"	+	valves: 2, fragments: 8

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 425 microns (0.425mm)

CAMS-44530 Grassy Narrows

normalized age: 370 ± 70

The bulrush seed (*Scirpus*; identified by A.M. Telka) was enclosed in muddy peat directly above Lake Agassiz Unconformity and overlying silty Lake Agassiz clay. Core '97301-011' was collected by D.L. Forbes, L. Hopkinson and F. Jodrey on March 24, 1997, from behind Sandy Bar in Grassy Narrows in the northern part of the south basin of Lake Winnipeg, Manitoba (51°00.98'N, 96°52.29'W), at an elevation of 217.7 m; water depth was 2.2 m; 0.74 m recovered from 1.59 m hammer core. This sample was submitted by D.L. Forbes to gain information on the onshore beach of Lake Winnipeg, and back-barrier marsh formation.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 0.74 m sediment recovered from 1.59 m hammer core, 10 cm in diameter, taken through ice in 2.2 m water depth. The dated bulrush seed (35-38 cm) at an elevation of 215.1 m asl was from a thin unit of muddy peat directly above erosional contact representing the Lake Agassiz Unconformity at 0.38 m down-core, and underlain by firm silty clay.

Comments (D.L. Forbes and A.M. Telka): This sample provides an age on muddy peat deposition in a back-barrier embayment about 2.6 m below present lake level in the northern south basin of Lake Winnipeg. It is anomalously young for a shoreline date at that elevation, suggesting that the material may be reworked from marshy shores nearby. The preservational state of the dated bulrush (*Scirpus*) seed was fair with remnants of basal filaments intact. Although the muddy peat contained an abundance of fossil remains, preservation varied greatly with most of the macrofossil seeds

displaying worn flattened surfaces, many of them being fragmented. The plant macrofossil assemblage was diverse containing abundant shoreline, aquatic emergent and submergent plants. Insect fossils were not as diverse and are represented mostly by aquatic forms.

Fossil Arthropod and Plant Macrofossil Report: 98-16 (A.M. Telka)
Sample No.: 97301-011
Interval: 35-38 cm
Laboratory No.: 3-27
Water Depth: 2.2 m
Material: muddy peat
Sample Vol.: 26 mL

PLANT MACROFOSSILS:		
Fungal Remains:		
fungal sclerotia	+	1
Non Vascular Plants:		
Bryophytes ....."mosses"	+	
Drepanocladius type	+	
Sphagnum sp.	+	
Vascular Plants:		
Pinaceae ....."pine family"		
Picea sp.	+	needle: 1 (well preserved)
Typhaceae ....."cat-tail family"		
Typha sp.	+	seeds: 6
Potamogetonaceae .."pondweed family"		
Potamogeton sp.	+	seeds: 2, seed fragment: 1, 'trap door': 1
Najadaceae ...."naiad family"		
Najas flexilis (Willd.)	+	half seed: 1
Alismaceae ....."water plantain family"		
Sagittaria spp.	+	seed embryos: 4
Gramineae ....."grass family"	+	seeds: 2
Cyperaceae ....."sedge family"	+	perigynum: 1
Carex trigonous type	+	seeds: 5, seed fragments: 3
Carex lenticular type	+	seeds: 18, seed fragments: 2
Eleocharis sp.	+	seeds: 13, seed fragment: 1
Eleocharis acicularis (L.) R.S.	+	seed: 1
Scirpus sp.	+	large seeds: 2, medium seeds: 6.5
Lemnaceae ....."duckweed family"		
Lemna? sp.	+	seed: 1
Juncaceae ....."rush family"		
Juncus/Luzula type	+	seed: 1
Polygonaceae ...."buckwheat family"		
Polygonum lapathifolium type	+	seeds: 2
Rumex sp.	+	seed: 1, calyx and seed: 1, seed fragment: 1, calyx fragment: 1
Chenopodiaceae .."goosefoot family"		
Chenopodium sp.	+	seeds: 1.5 (poorly preserved)
Ranunculaceae ..."crowfoot family"		
Ranunculus sceleratus type	+	seeds: 12, half seeds: 3
Ranunculus trichophyllus type	+	seeds: 2
Cruciferae ....."mustard family"		
Rorippa islandica (Oeder) Borbas	+	seeds: 3
Rosaceae ....."rose family"		
Potentilla norvegica L.	+	seeds: 2
Potentilla sp.	+	seed: 1
Haloragaceae ...."water milfoil family"		
Hippuris sp.	+	seed: 1
Verbenaceae ....."vervain family"		
Verbena sp.	+	seed: 1
Labiatae ....."mint family"		
Lycopus sp.	+	seeds: 2
Mentha sp.	+	seeds: 5.5
Unidentified plant taxa	+	seed fragments: 2, seed: 1 (poorly preserved), unknown capsule: 1
Other:		
charcoal	+	fragments: 8
wood	+	misc. fragments, few large pieces (rounded, no bark)
net-veined leaves	+	fragments: about 10
ANIMAL MACROFOSSILS:		
PORIFERA ....."sponges"		
HAPLOSCLERINA		
Spongillidae		
Spongilla type	+	4-cell: 13, single cell: 3, colony "mats": 2
ARTHROPODA		
INSECTA		
COLEOPTERA ....."beetles"	+	larval head: 1, pronotum: 1
Carabidae ....."ground beetles"	+	prosternal fragment: 1, metasternal fragment: 1
Staphylinidae ..."rove beetles"	+	elytron: 1
Olophrum rotundicolle (Sahlb.)	+	pronotum: 1
Helodidae ....."marsh beetles"	+	heads: 2, half elytron: 1, elytral fragment: 1
TRICHOPTERA ....."caddisflies"	+	'trap' fragments: 2 (mineral type)
DIPTERA ....."flies"	+	puparial fragments: 4 (few types); thorax: 1
Chironomidae ...."midges"	+	larval head capsules: 14.5
HYMENOPTERA ....."wasps and ants"	+	thorax: 1
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	+	ephippia: 13
MOLLUSCA	+	periostracum: fragment: 1
Unidentifiable animal taxa	+	cocoon fragment: 1
Other:		
soft bodied insects	+	fragments: 14

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 425 microns (0.425mm)

Observation Point Series

A series of wood samples from the foreshore of the present beach south of Observation Point on the southeastern shore of the south basin of Lake Winnipeg, about 10 km southwest of Manigatagan, Manitoba (51°04'N, 96°26'W), at an elevation of 217.7 m, was collected by E. Nielsen on August 14, 1996. These samples were submitted by E. Nielsen to gain information on the beach foreshore, and lake level change in Lake Winnipeg.

BGS-1912 Observation Point I

uncorrected age: 1795 ± 75

The tamarack wood sample (Observation Point 96-1; *Larix*; identified by E. Nielsen) was a tree stump rooted in calcareous sand. The submerged, rooted tree stump on the foreshore of the present beach had its root crown at 217.5 m asl i.e. about 20 cm below the level of Lake Winnipeg on day of collection.

BGS-1913 Observation Point II

uncorrected age: 1810 ± 80

The tamarack wood sample (Observation Point 96-2; *Larix*; identified by E. Nielsen) was a tree stump rooted in calcareous

sand. The submerged, rooted tree stump on the foreshore of the present beach had its root crown, at an elevation of 217.5 m asl, i.e. about 20 cm below the level of Lake Winnipeg on day of collection.

Comment (E. Nielsen): This log (96-2) and 96-1 (BGS-1912) are from the south side of Observation Point and are believed to be logs buried in an old fen which is now being exhumed by Lake Winnipeg shoreline erosion. These samples were intended to help determine the rate of water-level rise in the northern south basin of Lake Winnipeg, but the dates are anomalously old when compared to BGS-1632 (160 ± 70 yr BP).

BGS-1632 Observation Point III

uncorrected age: 160 ± 70

The wood (tamarack log and stump; *Larix*; identified by E. Nielsen) was from a surface collection on calcareous sand. Sample 'Man 93-1' was collected by E. Nielsen on May 24, 1993, from the upper foreshore of the present beach on the north side of Observation Point on the southeastern shore of the south basin of Lake Winnipeg, about 10 km southwest of Manigatagan, Manitoba (51°04'30"N, 96°26'25"W), at an elevation of 217.4 m. This sample was submitted by E. Nielsen to gain information on the beach foreshore, and Lake Winnipeg transgression.

Comment (E. Nielsen): The date will help determine the rate of transgression of the south basin of Lake Winnipeg, and possibly date a climate-induced low-water phase of Lake Winnipeg.

CAMS-35498 Black and Hecla Islands

normalized age: 3340 ± 50

The bulrush seed (*Scirpus*; identified by A.M. Telka) was enclosed in silt-clay mud directly above sharp contact, overlying firm crumbly silty clay. Core '96900 LW 217 PC' was collected by C.F.M. Lewis on August 28, 1996, from between Black and Hecla Islands in the south basin of Lake Winnipeg, Manitoba (51°08.0'N, 96°35.1'W), at an elevation of 218.1 m; water depth was 11.1 m; 3.10 m lake sediment recovered from 10 cm diameter piston core. This sample was submitted by C.F.M. Lewis to gain information on the Lake Agassiz Unconformity on Hecla-Black Sill, and lake level change.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 3.10 m lake sediment recovered with a 10 cm diameter by 9 m long piston corer in 11.1 m water depth. The dated bulrush seed (3.9 mg; 127-132 cm) was from Lake Winnipeg silty clay mud directly above upper sharp contact at 1.32 m down-core which was underlain by 1.70 m of firm crumbly silty clay (noncalcareous in upper part and calcareous in lower) over a lower erosional unconformity at 3.02 m down-core, interpreted as the Lake Agassiz Unconformity. This second contact is underlain by stiff, calcareous, silty clay. The sample elevation of 205.8 m asl is based on acoustic profile and seismic reflection travel time to the lower unconformity (Lewis et al., 2000).

Comments (D.L. Forbes and A.M. Telka): This date together with CAMS-46190 (also 3.3 ka) gives an age for the upper of two unconformities on the Hecla-Black Sill. This contact is interpreted as erosional truncation of infill sediments in a local depression (possible channel) cut into the underlying Lake Agassiz Sequence deposits prior to 3.9 ka (CAMS-46191). The preservational state of the dated bulrush seed was excellent with basal bristles intact. The sample contained many well preserved macrofossil seeds with the majority of the plants being shoreline inhabitants. Insect fossils were minimally represented with both aquatic and shoreline components.

Fossil Arthropod and Plant Macrofossil Report: 97-08 (A.M. Telka)
Sample No.: 96900 Lake Winnipeg Core 217
Interval: 127-132 cm below water sediment interface
Laboratory No.; 2-68
Water Depth: 11.1 m
Material: silt-clay mud
Sample Vol.: 85 mL (wet)

PLANT MACROFOSSILS:		
Non Vascular Plants:		
Bryophytes ....."mosses"	+	fragments: 2
Vascular Plants:		
Typhaceae....."cat-tail family"		
Typha sp.	+	seeds: 6
Potamogetonaceae.. "pondweed family"		
Potamogeton sp.	+	seed: 1
Alismaceae ....."water plantain family"		
Sagittaria sp.	+	seed: 1
Gramineae? ....."grass family"	+	seed: 1
Cyperaceae ....."sedge family"		
Carex sp.	+	seed: 1
Carex lenticular type	+	seeds: 3
Scirpus sp.	+	seeds: 6, one with remnants of bristles, fragments: 2
Polygonaceae ...."buckwheat family"		
Polygonum lapathifolium type	+	seed: 2, half seed: 1
Rumex sp.	+	seeds: with outer calyx: 3, seed only: 1
Chenopodiaceae .."goosefoot family"		
Chenopodium sp.	+	seed fragments: 5
Cruciferae? ....."mustard family"	+	seeds: 2
Ranunculaceae ..."crowfoot family"		
Ranunculus sceleratus type	+	seed: 1
Rosaceae ....."rose family"		
Potentilla sp.	+	seeds: 2
Potentilla paradoxa Nutt.	+	seeds: 2
Onagraceae .."evening primrose family"		
Epilobium sp. ..."willow herb"	+	seed: 1
Verbenaceae ....."vervain family"		
Verbena sp.	+	seed: 1
Labiatae ....."mint family"		
Lycopus sp.	+	seed: 1
Mentha sp.	+	seeds: 1.5
Plantaginaceae .."plantain family"		
Plantago major L.	+	seed: 1
Compositae ...."composite family"	+	seed fragment: 1
Unidentified plant taxa	+	seed fragments: 2
Other:		
twigs	+	with and without bark, *Salix*? sp.,
wood fragments	+	
charcoal	+	fragments: 14
net-veined leaves	+	fragments: 5
ANIMAL MACROFOSSILS:		
PORIFERA ....."sponges"		
HAPLOSCLERINA		
Spongillidae		
Spongilla type	+	colony 'mats' and single cell: 7
BRYOZOA		
Cristatella mucedo L.	+	statoblasts: 4
Plumatella sp.	+	statoblasts: 2

ARTHROPODA	
INSECTA	+ mandible: 1
EPHEMEROPTERA ..."mayflies"	+ mandibles: 21
HEMIPTERA ....."bugs"	+ head: 1
HOMOPTERA	
Cicadellidae? ..."leafhoppers"	+ hemelytral fragment: 1
COLEOPTERA ....."beetles"	+ elytral fragments: 4, tibia: 1
Staphylinidae ..."rove beetles"	+ elytral fragment: 1
Aleocharinae	+ elytron: 1, pronotum: 1
TRICHOPTERA ....."caddisflies"	+ larval: trap fragment: 1, frontoclypeal apotome: 1
DIPTERA ....."flies"	+ thorax: 1, puparium: 1
Chironomidae ...."midges"	+ larval head capsules: 31
CRUSTACEA	
Cladocera ....."water fleas"	
Daphnia sp.	+ ephippia: 18
Ostracoda ....."ostracodes"	+ intact valve: 1, valves: 4
Other:	
fish vertebrae and bone	+ 3

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 250 microns (0.25 mm)

CAMS-46190 Black and Hecla Islands

normalized age: 3340 ± 40

The bulrush seeds (*Scirpus*; identified by A.M. Telka) were enclosed in noncalcareous silty clay, directly below sharp contact over firm crumbly silty clay. Core '96900 LW 217 PC' was collected by C.F.M. Lewis on August 28, 1996, from between Black and Hecla Islands in the south basin of Lake Winnipeg, Manitoba (51°08.0'N, 96°35.1'W), at an elevation of 218.1 m; water depth was 11.1 m; 3.10 m lake sediment recovered from 10 cm diameter piston core. This sample was submitted by C.F.M. Lewis to gain information on lake level change, and the upper unconformity.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 3.10 m lake sediment recovered with a 10 cm diameter by 9 m long piston corer in 11.1 m water depth. The dated bulrush seeds (135-140 cm) were from crumbly silty clay directly below upper sharp contact, and were 1.62 m above a lower erosional unconformity at 3.02 m down-core, interpreted as the Lake Agassiz Unconformity. This second contact is underlain by stiff, calcareous, silty clay. The sample elevation of 205.7 m asl is based on acoustic profile and seismic reflection travel time to the lower unconformity (Lewis et al., 2000).

Comments (D.L. Forbes and A.M. Telka): This date gives an age of 3.3 ka for infill sediments below the upper of two unconformities on the Hecla-Black Sill. With CAMS-35498, it fixes the age of this unconformity, correlative with the main Lake Agassiz Unconformity, which truncates a local depression (possible channel) cut into the older sediments prior to 3.9 ka (CAMS-46191). The preservational state of the two bulrush seeds was good with remnants of the basal filaments and style tip intact. Macrofossils within this sample were not as diverse in comparison to the other two samples dated from this core. The plant macrofossils included mostly single seeds of shoreline taxa (*Rumex*, *Chenopodium*, *Potentilla*, *Verbena* and Compositae) and aquatic arrowhead (*Sagittaria*). Mostly aquatic sponges (*Spongilla* type) and immature forms of midges (Chironomidae) and mayflies (Ephemeroptera) represented faunal fossil remains.

Fossil Arthropod and Plant Macrofossil Report: 98-34 (A.M. Telka)
Sample No.: 96900 Lake Winnipeg Core 217
Interval: 135-140 cm below water sediment interface

Laboratory No.: 2-105
Water Depth: 11.1 m
Material: noncalcareous silty clay
Sample Vol.: 90 mL (wet)

PLANT MACROFOSSILS:	
Vascular Plants:	
Alismaceae ....."water plantain family"	
Sagittaria sp.	+ seed: 1
Gramineae ....."grass family"	+ seeds: 1.5
Cyperaceae ....."sedge family"	
Carex sp.	+ seed fragment: 1
Scirpus sp.	+ seeds: 2 medium size, one with partial basal filament
Polygonaceae ...."buckwheat family"	
Rumex sp.	+ seeds: 1.5
Chenopodiaceae ..."goosefoot family"	
Chenopodium sp.	+ seed fragments: 6
Rosaceae ....."rose family"	
Potentilla sp.	+ seeds: 1.5
Verbenaceae ....."vervain family"	
Verbena sp.	+ seed: 1
Compositae ...."composite family"	+ seed: 1
Unidentified plant taxa	+ seed: 1
Other:	
wood	+ charred fragments: 4
ANIMAL MACROFOSSILS:	
PORIFERA ....."sponges"	
HAPLOSCLERINA	
Spongillidae	
Spongilla type	+ 4 cell 'clumps': 5, single cells: many
ARTHROPODA	
INSECTA	
EPHEMEROPTERA ..."mayflies"	+ mandibles: 8
HEMIPTERA ....."bugs"	+ pronotum: 1
COLEOPTERA ....."beetles"	+ misc. frags: sternite: 1, elytral fragments: 2
Staphylinidae ..."rove beetles"	
Aleocharinae	+ elytron: 1, prosternum and mesosternum: 1
DIPTERA ....."flies"	+ puparial fragments: 2, thorax: 1
Chironomidae ...."midges"	+ larval head capsules: 22.5
CRUSTACEA	
Cladocera ....."water fleas"	
Daphnia sp.	+ ephippia: 3
Ostracoda ....."ostracodes"	+ valve: 1
ARACHNIDA	
Oribatei/Acari ..."mites"	+ 1
Other:	
periostracum	+ fragments: many

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 250 microns (0.25 mm)

CAMS-46191 Black and Hecla Islands

normalized age: 3910 ± 60

The 6 goosefoot seeds (*Chenopodium*; identified by A.M. Telka) were enclosed in noncalcareous silty clay, 1.2 m below upper contact over firm crumbly silty clay. Core '96900 LW 217 PC' was collected by C.F.M. Lewis on August 28, 1996, from between Black and Hecla Islands in the south basin of Lake Winnipeg, Manitoba (51°08.0'N, 96°35.1'W), at an elevation of 218.1 m; water depth was 11.1 m; 3.10 m lake sediment recovered from 10 cm diameter piston core.

This sample was submitted by C.F.M. Lewis to gain information on lake level change, and the lower unconformity.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 3.10 m lake sediment recovered with a 10 cm diameter by 9 m long piston corer in 11.1 m water depth. The dated goosefoot seeds (253-257 cm) were from crumbly silty clay below a sharp upper contact at 1.32 m down-core. The seeds were 0.45 m above a lower erosional unconformity at 3.02 m down-core, interpreted as the Lake Agassiz Unconformity. This second contact is underlain by stiff, calcareous, silty clay. The sample elevation of 204.6 m asl is based on acoustic profile and seismic reflection travel time to the lower unconformity (Lewis et al., 2000).

Comments (D.L. Forbes and A.M. Telka): This date gives a minimum age of 3.9 ka for the lower of two erosional contacts at this location on the Hecla-Black Sill. This lower contact is the base of a shallow depression (possible channel) and is filled with partially bedded crumbly silty clay, truncated at the upper contact at 3.3 ka (CAMS-35498 and CAMS-46190). The preservational state of the dated goosefoot seeds was excellent. The plant and insect fossil remains from this interval were well preserved and diverse. The dated goosefoot seeds comprised two species and were the most abundant macrofossil within this sample. Plant macrofossils included a few aquatics such as cat-tail (*Typha*), pondweed (*Potamogeton*) and naiad (*Najas flexilis*) but were predominantly represented by shoreline types of sedges (Cyperaceae including many *Scirpus*), buckwheat family (Polygonaceae), cinquefoil (*Potentilla*), vervain (*Verbena*) and water-starwort (*Callitriche*). Insect fossils included aquatic types such as water boatmen (Corixidae), predaceous diving beetles (Dytiscidae), and water scavenger beetles (Hydrophilidae). Terrestrial insect types included leaf beetles (Chrysomelidae) and ground beetles (Carabidae). The combined plant and insect macrofossil evidence suggests a shoreline close to the core site at 3.9 ka.

Fossil Arthropod and Plant Macrofossil Report: 98-35 (A.M. Telka)
Sample No.: 96900 Lake Winnipeg Core 217
Interval: 253-257 cm below water sediment interface
Laboratory No.: 2-84
Water Depth: 11.1 m
Material: noncalcareous silty clay
Sample Vol.: 70 mL (wet)

PLANT MACROFOSSILS:		
Non Vascular Plants:		
Bryophytes ....."mosses"	+	stem with leaves: 1
Vascular Plants:		
Sparganiaceae ..."bur reed family"		
Sparganium sp.	+	seed: 1
Typhaceae....."cat-tail family"		
Typha sp.	+	seeds: 2
Potamogetonaceae.. "pondweed family"		
Potamogeton sp.	+	half seed: 1
Najadaceae ....."naiad family"		
Najas flexilis (Willd.)	+	half seed: 1, seed fragment: 1
Gramineae? ....."grass family"	+	seed: 1
Cyperaceae ....."sedge family"		
Carex trigonous type.	+	seed: 1
Carex lenticular type	+	seed: 1
Scirpus sp.	+	seeds: 1.5
Polygonaceae ...."buckwheat family"		
Polygonum lapathifolium type	+	seeds: 2 (well preserved), half seeds: 5
Rumex sp.	+	seeds: 2, calyx fragment: 1
Chenopodiaceae .."goosefoot family"		
Chenopodium sp.	++	seeds: 29, half seeds: 6, seed fragments: 17
Rosaceae ....."rose family"		
Potentilla sp.	+	seeds: 5.5
Potentilla paradoxa Nutt.	+	seeds: 3
Callitrichaceae "water-starwort family"		
Callitriche sp.	+	seeds: 2 (small remnant fringe)
Verbenaceae ....."vervain family"		
Verbena sp.	+	seeds: 6, fragment: 1
Labiatae ....."mint family"		
Lycopus sp.	+	seeds: 2 (well preserved)
Plantaginaceae .."plantain family"		
Plantago major L.	+	seed: 1
Compositae ...."composite family"	+	seeds: 3
Unidentified plant taxa	+	seed fragments: 2
Other:		
charcoal	+	fragments: many
net-veined leaf	+	fragments: 3
ANIMAL MACROFOSSILS:		
PORIFERA ....."sponges"		
HAPLOSCLERINA		
Spongillidae		
Spongilla type	+	capsule: 1
BRYOZOA		
Cristatella mucedo L.	+	statoblast: 1
Plumatella sp.	+	statoblast: 1
ARTHROPODA		
INSECTA		
EPHEMEROPTERA ..."mayflies"	+	mandibles: 3
HEMIPTERA ....."bugs"		
Corixidae ....."water boatmen"	+	hemelytral fragment: 1
COLEOPTERA ....."beetles"	+	misc. fragments: head: 1, sternites: 5, mandible: 1, mesosternum:2, femur: 1
Carabidae ....."ground beetles"		
Bembidion acutifrons?	+	pronotum: 1
Dytiscidae ...."predaceous diving beetles"	+	elytral fragments: 3
Hydrophilidae ..."water scavenger beetles"	+	head: 1
Chrysomelidae ..."leaf beetles"		
Gonioctena sp.	+	half elytron: 1
Alticinae....."flea beetles"	+	half elytron: 1
TRICHOPTERA ....."caddisflies"	+	case fragment: 1, larval frontoclypeal apotome: 1
DIPTERA ....."flies"	+	puparial fragment: 1
Tipulidae ....."crane flies"		
Tipula sp.	+	head: 1
Chironomidae ...."midges"	+	larval head capsules: 4.5
HYMENOPTERA ...."wasps and ants"		
Ichneumonoidea .."ichneumons and braconids"		
Ichneumonidae	+	thorax: 1
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	+	ephippia: 1
Ostracoda ....."ostracodes"	+	valves: 17
ARACHNIDA		
Oribatei/Acari .."mites"	+	1
MOLLUSCA	++	small rounded fragments
Gastropoda ....."snails, limpets"	+	fragment: 1
Pelecypoda ....."clams, mussels"	+	valve: 1

Other:		
periostracum	++	small fragments: many, (not counted)
bone	+	large fragment: 1, small fragments: 2
fecal pellet?	+	1

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 250 microns (0.25 mm)

CAMS-34554 Washow Bay

normalized age: 3950 ± 60

The bulrush seed (*Scirpus*; identified by A.M. Telka) was enclosed in silt-clay, 40 cm above Lake Agassiz Unconformity overlying firm crumbly calcareous clay. Core '96900 LW 215 PC' was collected by C.F.M. Lewis on August 28, 1996, from Washow Bay, northwestern south basin, Lake Winnipeg, Manitoba (51°22.5'N, 96°34.3'W), at an elevation of 218.1 m; water depth was 11.6 m; 4.85 m lake sediment recovered from 10 cm diameter piston core. This sample was submitted by C.F.M. Lewis to gain information on the Lake Agassiz Unconformity in Lake Winnipeg, and assess post-Lake Agassiz Unconformity sedimentation.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 4.85 m lake sediment (3.61 m of Lake Winnipeg mud over 1.24 m of Lake Agassiz sediment) recovered with a 10 cm diameter by 9 m long piston corer in 11.6 m water depth. The dated bulrush seed (321.5 cm) lay within Lake Winnipeg silty clay mud, about 0.40 m above the Lake Agassiz Unconformity, which is underlain by firm crumbly calcareous clay mud. The sample elevation of 203.3 m asl is based on acoustic profile and seismic reflection travel time to the Lake Agassiz Unconformity (Lewis et al., 2000).

Comments (A.M. Telka and D.L. Forbes): The preservational state of the dated bulrush seed was fair (delicate basal bristles absent), however the remaining plant macrofossil and insect fossil assemblage showed no sign of redeposition. This sample had a richer insect assemblage than the lower dated interval (see CAMS-34555, below), with more shoreline-type insects including leafhoppers (Cicadellidae) and leaf beetles (Chrysomelidae: *Donacia*). The combined sedimentological and fossil evidence demonstrates that the Lake Agassiz Unconformity at this site was cut prior to about 4.0 ka, when the shoreline was closer to the core site than it is today.

Fossil Arthropod and Plant Macrofossil Report: 97-06 (A.M. Telka)
Sample No.: 96900 Lake Winnipeg Core 215
Interval: 321.5 cm below water sediment interface
Laboratory No.: 2-24
Water Depth: 11.6 m
Material: silt-clay mud
Sample Vol.: 47 mL (wet)

PLANT MACROFOSSILS:		
Algal Remains:		
Characeae		
Chara/Nitella type	+	oogonium: 1
Non Vascular Plants:		
Bryophytes ....."mosses"	+	fragments: 4, stem with no leaves: 1
Vascular Plants:		
Typhaceae .. ...."cat-tail family"		
Typha sp.	+	seeds: 11
Potamogetonaceae.. "pondweed family"		
Potamogeton sp.	+	'trap door': 1
Alismaceae ....."water plantain family"		
Sagittaria sp.	+	seeds: 2, embryos: 3.5
Gramineae ....."grass family"	+	seeds: 5
Cyperaceae ....."sedge family"		
Carex trigonous type	+	seed: 1
Eleocharis sp.	+	half seed: 1
Scirpus sp.	+	seeds: 6 (two have split open and are filled with sand, seed fragments: 3
Polygonaceae ...."buckwheat family"		
Polygonum lapathifolium type	+	seed: 1
Rumex sp.	+	seeds: 1.5, calyx: 2
Chenopodiaceae .."goosefoot family"		
Chenopodium sp.	+	seed fragments: 2
Ranunculaceae ..."crowfoot family"		
Ranunculus sceleratus type	+	half seed: 1
Rosaceae ....."rose family"		
Potentilla sp.	+	seeds: 2, half seeds: 2
Onagraceae .."evening primrose family"		
Epilobium sp. ..."willow herb"	+	seed: 1
Labiatae ....."mint family"		
Lycopus sp.	+	seed: 1
Mentha sp.	+	seed: 1
Compositae ...."composite family"		
Eupatorium sp.	+	seed: 1
Unidentified plant taxa	+	seed: 1
Other:		
net-veined leaves	+	fragments: thick and thin leaf types
charcoal	++	
ANIMAL MACROFOSSILS:		
PORIFERA ....."sponges"		
HAPLOSCLERINA		
Spongillidae		
Spongilla type	+	colony 'mats': 6
BRYOZOA		
Plumatella sp.	+	statoblasts: 3
ARTHROPODA		
INSECTA		
EPHEMEROPTERA ..."mayflies"	+	larval mandibles: 13
HOMOPTERA		
Cicadellidae ...."leafhoppers"	+	wing fragment: 1
COLEOPTERA ....."beetles"	+	misc.fragments: elytral fragments, tibia/femur: 3, sternites: 8
Dytiscidae ...."predaceous diving beetles"	+	pronotum: 1
Chrysomelidae ..."leaf beetles"	+	elytral fragment: 1
Donacia sp.	+	elytron: 1
Curculionidae ..."weevils"	+	elytron: 1
Apion sp.	+	elytron: 1
TRICHOPTERA ....."caddisflies"	+	larval case fragment: 1, frontoclypeal apotome: 1
DIPTERA ....."flies"	+	puparial fragments: 2, thoraces: 3,
Chironomidae ...."midges"	+	larval head capsules: 9
HYMENOPTERA ..."wasps and ants"		
Ichneumonoidea .."ichneumons and braconids"	+	thorax: 1
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	+	ephippia: 14
Ostracoda ....."ostracodes"	+	valve: 1
MOLLUSCA		
Gastropoda ....."snails, limpets"	+	4
Pelecypoda ....."clams, mussels"	+	valves: 7, small fragments: abundant

Other:		
fish scale	+	1
iron pyrite	+	

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 250 microns (0.25 mm)

CAMS-34555 Washow Bay

normalized age: 4030 ± 50

The bulrush seed (*Scirpus*; identified by A.M. Telka) was enclosed in silt-clay, 13 cm above Lake Agassiz Unconformity overlying firm crumbly calcareous clay. Core '96900 LW 215 PC' was collected by C.F.M. Lewis on August 28, 1996, from Washow Bay, northwestern south basin, Lake Winnipeg, Manitoba (51°22.5'N, 96°34.3'W), at an elevation of 218.1 m; water depth was 11.6 m; 4.85 m lake sediment recovered from 10 cm diameter piston core. This sample was submitted by C.F.M. Lewis to gain information on the Lake Agassiz Unconformity, and lake level changes in Lake Winnipeg.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 4.85 m lake sediment (3.61 m of Lake Winnipeg mud over 1.24 m of Lake Agassiz sediment) recovered with a 10 cm diameter by 9 m long piston corer in 11.6 m water depth. The dated bulrush seed (348 cm) lay within Lake Winnipeg silty clay mud, about 0.13 m above erosional contact at Lake Agassiz Unconformity, which is underlain by firm crumbly calcareous clay. The sample elevation of 203.1 m asl is based on acoustic profile and seismic reflection travel time to the Lake Agassiz Unconformity (Lewis et al., 2000).

Comments (A.M. Telka and D.L. Forbes): The preservational state of the dated bulrush seed was good, with remnants of basal bristles intact. Many of the fossils within this sample were well preserved. Plant macrofossils were more abundant than insect fossils and included both shoreline and aquatic plants, the most abundant being well preserved bulrush (*Scirpus*) seeds. Complete mollusc shells (both snails and clams) were also very abundant. The combined plant and insect macrofossil and sedimentological evidence demonstrates that the Lake Agassiz Unconformity at this site was cut prior to 4.0 ka, when the shoreline was closer to the core site than it is today.

Eight samples from Lake Winnipeg sediment were examined in core 215, beginning with the basal unit above the unconformity and extending up to 195 cm core depth. The combined plant macrofossil and insect fossil evidence suggests that, with the onset of Lake Winnipeg sedimentation, the core site was shallow at 4.0 ka and the shoreline remained close to this site until 250 cm depth in core, after which the lake expanded and the shoreline moved away from the core site. Two shell samples were obtained from this core at 373-375 cm and 457-459 cm, both below the Lake Agassiz Unconformity. These as-yet undated specimens were identified by E. Nielsen and B. McKillop as *Helisoma pilsbryi infracarinatum* (Baker, 1932) (upper sample) and *Fossaria modicella* (Say, 1825) (lower sample).

Fossil Arthropod and Plant Macrofossil Report: 97-07 (A.M. Telka)
Sample No.: 96900 Lake Winnipeg Core 215
Interval: 348 cm below water sediment interface
Laboratory No.: 2-26
Water Depth: 11.6 m
Material: silt-clay mud
Sample Vol.: 54 mL (wet)

PLANT MACROFOSSILS:		
Vascular Plants:		
Typhaceae....."cat-tail family"		
Typha sp.	+	seeds: 4
Potamogetonaceae .."pondweed family"		
Potamogeton sp.	+	seeds: 4, seed fragment: 1
Najadaceae ....."naiad family"		
Najas flexilis (Willd.)	+	seed fragment: 1
Alismaceae ...."water plantain family"		
Sagittaria sp.	+	seeds: 2
Gramineae ....."grass family"	+	seeds: 3
Cyperaceae ....."sedge family"		
Carex sp.	+	seed: 1, seed fragments: 4
Eleocharis sp.	+	seeds: 2
Scirpus spp.	++	seeds: 14
Polygonaceae ...."buckwheat family"		
Polygonum lapathifolium type	+	seed with iron pyrite on surface: 1
Rumex sp.	+	seed: 1, calyx: 2
Rosaceae ....."rose family"		
Potentilla sp.	+	seeds: 2
Other:		
charcoal	+	fragments: 4
net-veined leaves	+	fragment: 1
ANIMAL MACROFOSSILS:		
PORIFERA ....."sponges"		
HAPLOSCLERINA		
Spongillidae		
Spongilla type	+	colonies and singe cell, some with spicules: 11
BRYOZOA		
Cristatella mucedo L.	+	half statoblast: 1
ARTHROPODA		
INSECTA	+	immature larval head capsule: 1
EPHEMEROPTERA ...."mayflies"	+	larval mandibles: 6
COLEOPTERA ...."beetles"	+	elytron: 1
Helodidae ....."marsh beetles"	+	elytron: 1
DIPTERA ...."flies"	+	thorax: 1
Chironomidae ...."midges"	+	larval head capsule: 1
CRUSTACEA		
Cladocera ...."water fleas"		
Daphnia sp.	+	ephippia: 2
Ostracoda ....."ostracodes"	+	valves: 4
MOLLUSCA		
Gastropoda ...."snails, limpets"	+++	>50 complete snails, fragments
Pelecypoda ....."clams, mussels"	+++	intact valves, valves
Other:		
iron pyrite precipitates	+	

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 250 microns (0.25 mm)

The 'North Basin'

CAMS-34552 Passage Point

normalized age: 1020 ± 50

The willow twig (*Salix*; identified by A.M. Telka) was enclosed in basal peat overlying stiff blue clay, under 10 cm of sand. Core '94307-010' was collected by D.L. Forbes and D. Frobel on September 10, 1994, from near Passage Point on the western shore of Fisher Bay in the southern part of the north basin of Lake Winnipeg, Manitoba (51°51.3'N, 97°15.4'W), at an elevation of 216.4 m. This sample was submitted by D.L. Forbes to gain information on lake level change in Lake Winnipeg, and shoreline regression.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 1.55 m Hiller core taken through beach-face at an eroding coastal site. The core stratigraphy consisted of 10 cm sand over 133 cm of peat resting on stiff blue clay.

Comments (A.M. Telka and D.L. Forbes): The delicate twig of willow (*Salix* with bark intact) was from near the base of the peat unit (132-142 cm), about 1.0 m below mean lake level (217.7 m asl). It provides an age estimate of 1.0 ka for lower lake level at this site. The plant macrofossil assemblage was diverse, containing both shoreline and terrestrial components such as larch (*Larix*) and spruce (*Picea*) needles, birch (Betulaceae) seeds, alder (*Alnus*) seeds and bracts, as well as sedge (*Carex*), cat-tail (*Typha*) and moss fragments. Insect fossils were rare. The peat unit is interpreted to have accumulated vertically in a backshore setting before being truncated at the present shoreline and buried beneath a thin transgressive beach veneer.

Fossil Arthropod and Plant Macrofossil Report: 98-02 (A.M. Telka)
Sample No.: 94307-010
Interval: 132-142 cm
Laboratory No.: 2-12
Material: peat
Sample Vol.: 30 mL

PLANT MACROFOSSILS:		
Fungal Remains:		
fungal sclerotia	+	25
Non Vascular Plants:		
Bryophytes ....."mosses"	+	stems with leaves: 6
Sphagnum sp.	+	leaves: 12
Vascular Plants:		
Pinaceae ....."pine family"		
Larix sp.	+++	needles and fragments: abundant (not counted)
Picea sp.	++	needle fragments: many (not counted)
Typhaceae ....."cat-tail family"		
Typha sp.	+	seeds: 3
Gramineae? ....."grass family"	+	seed: 1
Cyperaceae ....."sedge family"		
Carex sp.	+	seeds: 5
Carex trigonous type	+	seed: 1 (with perigynum)
Carex lenticular type	+	seed: 1 (with perigynum)
Salicaceae ....."willow family"		
Salix sp.	+	persistent bud: 1
Betulaceae ....."birch family"	+	seeds: 4 (no wings)
Alnus sp.	+	bract: 1
Betula sp.	+	seeds: 3.5, bract fragment: 1
Rosaceae ...."rose family"	+	seed fragments: 2
Potentilla norvegica L.	+	seed: 1
Rubus idaeus L.	+	seed fragment: 1
Rubus sp.	+	half seed: 1
Unidentified plant taxa	+	seed fragments: 3
Other:		
charred wood/charcoal	++	fragments: many, (not counted)
wood	+	fragments: with and without bark, not rounded
net-veined leaves	++	fragments: many, (not counted)
ANIMAL MACROFOSSILS:		
ARTHROPODA		
INSECTA		
COLEOPTERA ....."beetles"	+	pronotum: 1
Carabidae? ....."ground beetles"	+	elytral fragments: 3
Staphylinidae ..."rove beetles"	+	half elytron: 1
Chrysomelidae ..."leaf beetles"	+	half elytron: 1
LEPIDOPTERA .. "butterflies/moths"	+	larval head capsules: 2
DIPTERA ....."flies"	+	puparial fragments: 9
Chironomidae ...."midges"	+	larval head capsules: 2.5
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	+	ephippia: 1
ARACHNIDA		
Oribatei/Acari .."mites"	+	1

Key: + = taxon present, +++ = taxon is abundant;
- based upon examination of organics greater than 250 microns (0.25 mm)

CAMS-46187 The Narrows

normalized age: 2540 ± 60

The spruce needle (*Picea*; identified by A.M. Telka) was enclosed in basal, noncalcareous silty clay mud directly above a sharp Lake Agassiz contact. Core '96900 LW 213 PC' was collected by C.F.M. Lewis on August 27, 1996, from north of The Narrows in the southern part of the north basin of Lake Winnipeg, Manitoba (51°52.5'N, 96°56.5'W), at an elevation of 217.8 m; water depth was 11.5 m; 1.43 m lake sediment recovered from 10 cm diameter piston core. This sample was submitted by C.F.M. Lewis to gain information on lake level change, and the initiation of Lake Winnipeg sedimentation.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 1.43 m lake sediment (0.15 m Lake Winnipeg silty clay mud over 1.28 m Lake Agassiz clay and silty clay) recovered with a 10 cm diameter by 9 m long piston corer in 11.5 m water depth. The dated spruce needle (010-015 cm) was from basal Lake Winnipeg mud directly overlying sharp erosional contact with a trace of grit, representing the Lake Agassiz Unconformity, and underlain by stiff, fractured, noncalcareous clay in upper 30 cm below contact and stiff, finely laminated, calcareous silty clay below that. The sample elevation of 204.3 m asl is based on acoustic profile and seismic reflection travel time to the Lake Agassiz Unconformity (Lewis et al., 2000).

Comments (A.M. Telka): This date of 2.5 ka provides an age estimate for the onset of Lake Winnipeg sedimentation in the southern part of the north basin. The preservational state of the dated spruce needle fragment was poor (5 mm in length with needle tip intact, no base). The plant macrofossils within this sample were sparse and included a single seed of cat-tail (*Typha*) and one well preserved arboreal birch seed (*Betula*). Insect fossils were minimally represented and include mostly aquatic immatures of mayflies (Ephemeroptera), midges (Chironomidae) and water fleas (*Daphnia*).

Fossil Arthropod and Plant Macrofossil Report: 98-33 (A.M. Telka)
Sample No.: 96900 Lake Winnipeg Core 213
Interval: 10-15 cm below water sediment interface
Laboratory No.: 2-111
Water Depth: 11.5 m
Material: noncalcareous silty clay mud
Sample Vol.: 90 mL (wet)

PLANT MACROFOSSILS:		
Non Vascular Plants:		
Bryophytes ....."mosses"	+	stem fragments: 2
Sphagnum sp.	+	leaves: 12
Vascular Plants:		
Pinaceae ....."pine family"		
Picea sp. ....."spruce"	+	needle fragments: 2 (blackened)

F2

Typhaceae....."cat-tail family"		
Typha sp.	+	seeds: 1.5
Betulaceae ....."birch family"		
Betula arboreal type	+	seed: 1 (well preserved)
Unidentified plant taxa	+	unknown 'a' seed: 1
Other:		
wood	+	fragment: 1
charcoal	+	fragments: 2
net-veined leaf	+	fragment: 1
ANIMAL MACROFOSSILS:		
ARTHROPODA		
INSECTA		
EPHEMEROPTERA ..."mayflies"	+	larval mandibles: 16
HEMIPTERA ....."bugs"		
Corixidae? ....."water boatmen"	+	hemelytral fragment: 1
COLEOPTERA ... ..."beetles"		
Chrysomelidae? .."leaf beetles"	+	elytral fragments: 3
DIPTERA ....."flies"	+	thorax: 1
Chironomidae ...."midges"	+	larval head capsules: 11.5
HYMENOPTERA ..."wasps and ants"	+	thoracic fragment: 1
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	+	ephippia: 16
Unidentifiable animal taxa	+	misc. soft bodied insect fragments: 3

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 250 microns (0.25 mm)

CAMS-38679 The Narrows

normalized age: 3630 ± 50

The wood (unidentified) was enclosed in noncalcareous silty clay mud about 72 cm above erosional Lake Agassiz Unconformity. Core '96900 LW 214 PC' was collected by C.F.M. Lewis on August 27, 1996, from north of The Narrows, about 9 km from nearest shoreline in the southern part of the north basin of Lake Winnipeg, Manitoba (51°56.1'N, 96°59.1'W), at an elevation of 217.8 m; water depth was 11.3 m; 4.25 m lake sediment recovered from 10 cm diameter piston core. This sample was submitted by C.F.M. Lewis to gain information on lake level change, and Lake Winnipeg sediments.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 4.25 m lake sediment (3.75 m Lake Winnipeg silty clay mud over 0.50 m Lake Agassiz clayey silt) recovered with a 10 cm diameter by 9 m long piston corer in 11.3 m water depth. The dated wood was from within soft, noncalcareous, mottled (burrowed) and faintly laminated, silty clay mud (298-303 cm), about 0.72 m above erosional Lake Agassiz Unconformity, which is underlain by firm to stiff calcareous clayey silt with dropstones. The sample elevation of 203.2 m asl is based on acoustic profile and seismic reflection travel time to the Lake Agassiz Unconformity (Lewis et al., 2000).

Comments (A.M. Telka and D.L. Forbes): This date indicates that backflooding had penetrated into this narrow southern portion of the north basin prior to 3.6 ka. The preservational state of the wood fragment was fair, suggesting the wood was transported some distance prior to deposition. There was minimal representation of plant macrofossils within this sample with mosses and cat-tail (*Typha*) comprising the assemblage. Insect fossils were also present in minimal numbers. The examination of the macrofossil assemblage 10 cm above this dated interval (288-293 cm) revealed an assemblage slightly richer and higher in numbers of cat-tail, mosses and marsh beetles (Helodidae), suggesting a lake-marginal or nearby marsh environment at 3.6 ka.

Fossil Arthropod and Plant Macrofossil Report: 97-05 (A.M. Telka)
Sample No.: 96900 Lake Winnipeg Core 214
Interval: 298-303 cm below water sediment interface
Laboratory No.: 2-101
Water Depth: 11.3 m
Material: silty clay mud
Sample Vol.: 90 mL (wet)

PLANT MACROFOSSILS:		
Non Vascular Plants:		
Bryophytes ....."mosses"	+	leaves: 3
Sphagnum sp.	+	leaf: 1
Vascular Plants:		
Typhaceae....."cat-tail family"		
Typha sp.	+	seeds: 3
Other:		
wood	+	fragments: 4
ANIMAL MACROFOSSILS:		
ARTHROPODA		
INSECTA		
EPHEMEROPTERA ..."mayflies"	+	larval mandibles: 8
HEMIPTERA ....."bugs"		
Corixidae ....."water boatmen"	+	hemelytral fragment: 1
COLEOPTERA ....."beetles"	+	elytral fragment: 1, metasterna: 2, sternites: 6
Hydrophilidae ..."water scavenger beetles"	+	elytral fragment: 1
Staphylinidae ..."rove beetles"	+	head: 1
Omaliinae	+	head: 1
Helodidae ....."marsh beetles"	+	elytral fragments: 2
DIPTERA ....."flies"	+	thorax: 1
Chironomidae ...."midges"	+	larval head capsules: 18
HYMENOPTERA ..."wasps and ants"	+	ovipositor: 1, thorax: 1
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	+	ephippia: 4
ARACHNIDA		
Araneae ....."spiders"	+	cephalothorax: 1
Other:		
bone	+	fragment: 1

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 250 microns (0.25 mm)

Disbrowe Point Series

A series of wood samples from about 2 m above the present lake level at Disbrowe Point on the eastern shore of the north basin of Lake Winnipeg, Manitoba (52°25'N, 97°08'W), at an elevation of about 219 m, was collected by E. Nielsen and D.L. Forbes on August 17, 1996. These samples were submitted by E. Nielsen to gain information on beach ridge (spit) development in Lake Winnipeg and lake level change.

BGS-1910 Disbrowe Point I

uncorrected age: 130 ± 70

The wood sample (Disbrowe Point 96-1; *Pinus*; identified by E. Nielsen), enclosed in calcareous sand, was freshly exposed in a dune ridge with a buried line of logs about 2 m above the present lake level.

BGS-1911 Disbrowe Point II

uncorrected age: 260 ± 75

The wood sample (Disbrowe Point 96-2; *Pinus*; identified by E. Nielsen), enclosed in calcareous sand, was freshly exposed in a dune ridge with a buried line of logs about 2 m above the present lake level.

Comment (E. Nielsen and D.L. Forbes): These dates provide a minimum age for the spit (Sandy Bar = Disbrowe Point) and date the washover that planed off the dune ridge. Although the point did not originate as a spit (Forbes, 2000), it now functions as such. The dated section is near the narrowest part about halfway along the spit.

CAMS-44526 Berens River

normalized age: modern

The raspberry seeds (*Rubus idaeus* L.; identified by A.M. Telka) were enclosed in a paleosol. Sample 97301-007 was collected by D.L. Forbes and L. Hopkinson on March 22, 1997, from north of the Berens River, off Disbrowe Point in the north basin of Lake Winnipeg, Manitoba (52°24.92'N, 97°06.94'W), at an elevation of 220 m. The buried soil horizon in the dunes on the neck of Disbrowe Point was about 2.4 m above lake-ice level. This sample was submitted by D.L. Forbes to gain information on the onshore beach, and the dune formation.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Comment (D.L. Forbes): The modern date on this sample demonstrates that dune migration on the lakeward half of the Disbrowe Point 'spit' at its narrowest part has been active in recent time. The driftwood ages from the face of the dune in this vicinity (see BGS-1910, p.87, and -1911, p. 88) show that washover trimmed the dune in at least one place here within the past 130 radiocarbon years.

Fossil Arthropod and Plant Macrofossil Report: 98-04 (A.M. Telka)
Sample No.: 97301-007
Laboratory No.: 2-113
Material: sand with organics
Sample Vol.: 125 mL

PLANT MACROFOSSILS:	
Fungal Remains:	
fungal sclerotia	+ 16
Vascular Plants:	
Equisetaceae ...."horsetail family"	
Equisetum sp.	+ large stem fragment: 1
Typhaceae....."cat-tail family"	
Typha sp.	+ seeds: 2
Gramineae? ....."grass family"	+ seed: 1
Cyperaceae ....."sedge family"	
Carex trigonous type	+ seeds: 2
Carex lenticular type	+ seeds: 2
Chenopodiaceae .."goosefoot family"	
Chenopodium sp.	+ seeds: 1.5
Rosaceae ....."rose family"	
Potentilla spp.	+ seeds: 2
Rubus idaeus L.	+ seeds: 2.5
Umbelliferae ...."parsley family"	
Cicuta sp.	+ seed: 1, seed fragments: 3
Ericaceae ....."heath family"	
Chamaedaphne calyculata (L.) Moench.	+ seed: 1
Primulaceae ....."primrose family"	
Lysimachia sp.	+ seeds: 4
Gentianaceae ...."gentian family"	
Menyanthes trifoliata L.	+ seeds: 4.5
Lentibulariaceae "bladderwort family"	
Pinguicula? sp.	+ seed: 1
Unidentified plant taxa	+ unknown seeds: 3 (three types); seed fragments: 5
Other:	
wood	+ many large pieces, charred wood (worn): 2, twigs: few
charcoal	+ fragments: 4
ANIMAL MACROFOSSILS:	
BRYOZOA	
Cristatella mucedo L.	+ statoblast: 1
ARTHROPODA	
INSECTA	
HEMIPTERA ....."bugs"	
Pleidae....."small backswimmers"	
Plea striola Fieber	+ head: 1
COLEOPTERA ....."beetles"	+ elytra: 2
Staphylinidae ..."rove beetles"	
Lathrobium sp.	+ head: 1
Scarabaeidae ...."scarab beetles"	+ articulated legs: 4
Curculionidae ..."weevils"	
Sitona sp.	+ head: 1
DIPTERA ....."flies"	+ puparial fragments: 5 (many different types)
ARACHNIDA	
Oribatei/Acari .."mites"	+ 6

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 250 microns (0.25 mm)

CAMS-44527 Disbrowe Point

normalized age: 2510 ± 50

The unidentified wood twig was enclosed in the top of a firm black peat below pebbly sand, and overlying silt and granules and Lake Agassiz clay. Core '97301-008' was collected by D.L. Forbes, L. Hopkinson and F. Jodrey on March 22, 1997, from north of the Berens River, off Disbrowe Point in the north basin of Lake Winnipeg, Manitoba (52°25.062'N, 97°06.965'W), at an elevation of 217.7 m; water depth was 2.6 m; 0.67 m recovered from 1.07 m hammer core. This sample was submitted by D.L. Forbes to gain information on lake level change in Lake Winnipeg, and submerged shoreline.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 0.67 m sediment recovered from 1.07 m hammer core, 10 cm in diameter, taken through ice in 2.6 m water depth. The dated twig (5-7 cm depth) at an elevation of 215.1 m asl was just below pebbly sand (0-5 cm) at the top of a 29 cm-thick peat unit underlain by 15 cm of silt and granules over stiff Lake Agassiz clay.

Comments (D.L. Forbes and A.M. Telka): The age of 2.5 ka provides a maximum age for the termination of peat deposition at this site lakeward of the Disbrowe Point beach, at least 2.5 m below present lake level. It demonstrates landward retreat of the shoreline as lake level rose at the south end of the north basin. The preservational state of the delicate dated twig with bark intact (indicating minimal transport) was excellent. Most of the organics within the dated peat unit consisted of well preserved fragments of wood, some being identified as willow (*Salix*). Macrofossil seeds and/or needles of larch (*Larix*), birch (*Betula*), alder (*Alnus incana*) and spruce (*Picea*) dominate the assemblage with minor

representation of shoreline taxa including heaths (*Chamaedaphne calyculata*) and cat-tail (*Typha*). The insect macrofossil assemblage contained mostly hygrophilous type insects including many small articulated rove beetles (Staphylinidae), leaf beetles (*Chrysomela lineatopunctata* Forst.) which live on willow, poplar or alder, and marsh beetles (Helodidae).

Fossil Arthropod and Plant Macrofossil Report: 98-05 (A.M. Telka)
Sample No.: 97301-008
Interval: 5-7 cm
Laboratory No.: 3-9
Water Depth: 2.6 m
Material: firm black peat
Sample Vol.: 20 mL

PLANT MACROFOSSILS:		
Fungal Remains:		
fungal sclerotia	+	3.5
Non Vascular Plants:		
Bryophytes ....."mosses"		
Sphagnum sp.	++	many leaves, (not counted)
Vascular Plants:		
Pinaceae ....."pine family"		
Larix sp.	++	needle fragments: 60
Picea sp.	+	needle fragments: 3
Typhaceae ....."cat-tail family"		
Typha sp.	+	seeds: 3
Salicaceae ....."willow family"		
Salix sp.	+	twigs, persistent buds
Betulaceae ....."birch family"	+	seeds: 14 (poorly preserved, no wings)
Alnus incana (L.) Moench.	+	seed: 1
Betula sp.	+	seeds: 2
Rosaceae ....."rose family"		
Potentilla palustris (L.) Scop.	+	seed: 1
Ericaceae ....."heath family"		
Chamaedaphne calyculata (L.) Moench.	+	seed: 9 (including two charred seeds)
Unidentified plant taxa	+	seed fragments: 2, unknown capsule: 1
Other:		
wood	+	many large pieces (1.5 x 1.0 cm), twigs: with bark mostly, some without
charcoal	+	fragments: 5
net-veined leaves	+	fragments: 9
rhizomes	+	fragments: 3
ANIMAL MACROFOSSILS:		
ARTHROPODA		
INSECTA		
COLEOPTERA ....."beetles"	+	head: 1, pronotum: 1, pronotal fragments: 2, elytron: 1, prosternum: 1, sternites: 4, legs: 5, larval head capsule: 1, metasternum: 1
Carabidae ....."ground beetles"	+	mandibles: 2
Dytiscidae? ..."predaceous diving beetles"	+	elytral fragment: 1
Staphylinidae ..."rove beetles"	+	pronota: 2, elytron: 1, articulated pronotum: 1, articulated elytra: 1
Stenus sp.	+	elytra: 2
Pselaphidae ....."short-winged mold beetles"		
Brachyglutini		
Reichenbachia? sp.	+	heads: 3, pronota: 2, elytron: 1
Helodidae ....."marsh beetles"	+	heads: 2, half pronotum: 1, elytral fragments: 2, elytra: 2,
Chrysomelidae ..."leaf beetles"		
Chrysomela lineatopunctata Forst.	+	elytron: 1
Curculionidae ..."weevils"	+	head: 1
TRICHOPTERA ....."caddisflies"	+	larval frontoclypeal apotomes: 2
DIPTERA ....."flies"	+	puparial fragments: 4, thorax: 1
Tipulidae ....."crane flies"		
Tipula sp.	+	head: 1
Chironomidae ...."midges"	+	larval head capsule: 1
HYMENOPTERA ....."wasps and ants"	+	thorax: 1
Formicidae ....."ants"	+	head: 1
ARACHNIDA		
Oribatei/Acari .."mites"	+	4
Hydrozetidae		
Hydrozetes type	+	2
Araneae ....."spiders"	+	palp: 1, cephalothoracic fragment: 1

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 250 microns (0.25 mm)

CAMS-35497 Berens Island

normalized age: 3730 ± 70

The juniper seed (*Juniperus communis* L.; identified by A.M. Telka) was enclosed in noncalcareous silt 7 cm above the Lake Agassiz Unconformity, over stiff calcareous silty clay. Core '96900 LW 209 PC' (095-097 cm) was collected by C.F.M. Lewis on August 26, 1996, from north of Berens Island, 24 km from the eastern shore in the north basin of Lake Winnipeg, Manitoba (52°30.9'N, 97°34.8'W), at an elevation of 217.7 m; water depth was 16.5 m; 1.65 m lake sediment recovered from 10 cm diameter piston core. This sample was submitted by C.F.M. Lewis to gain information on lake level change, and the Lake Agassiz Unconformity in Lake Winnipeg.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 1.65 m lake sediment (1.04 m Lake Winnipeg silty clay mud and silt over 0.61 m stiff Lake Agassiz silty clay) recovered with a 10 cm diameter by 9 m long piston corer in 16.5 m water depth. The dated juniper seed was from a 9 cm-thick silt unit near the base of Lake Winnipeg sediment, 7 cm above Lake Agassiz Unconformity, which is underlain by stiff, finely laminated, calcareous silty clay. The sample elevation of 200.0 m asl is based on acoustic profile and seismic reflection travel time to the Lake Agassiz Unconformity (Lewis et al., 2000).

Comments (A.M. Telka): Insect fossils within this sample were abundant and diverse in relation to plant macrofossils. This sample was the richest observed from the north basin. The insect assemblage contained many delicate fossils, both of aquatic types, including water boatmen (Corixidae), water scavenger beetles (Hydrophiilidae), predaceous diving beetles (*Colymbetes*), and numerous midges (Chironomidae), and of many shoreline types, including shore bugs (Saldidae), marsh beetles (Helodidae), leaf hoppers (Cicadellidae), and jumping plant lice (Psyllidae). This sample also contained fossils of the bark beetle (Scolytidae) indicating the presence of trees nearby. The plant macrofossils comprised mostly cat-tail (*Typha*) and a few spruce (*Picea*) needle fragments and the dated ground juniper seed (*Juniperus communis* L.). The preservational state of the plant and insect macrofossils within this

sample was excellent. The combined plant macrofossil and insect fossil evidence suggests a shallow marsh environment with shoreline close to the core site at 3.7 ka.

Fossil Arthropod and Plant Macrofossil Report: 97-04 (A.M. Telka)
Sample No.: 96900 Lake Winnipeg Core 209
Interval: 95-97 cm below water sediment interface
Laboratory No.: 2-61
Water Depth: 16.5 m
Material: noncalcareous silt
Sample Vol.: 65 mL (wet)

PLANT MACROFOSSILS:		
Algal Remains:		
Characeae		
Chara/Nitella type	+	oogonium: 1
Non Vascular Plants:		
Bryophytes ....."mosses"		
Sphagnum sp.	+	leaf: 1
Vascular Plants:		
Pinaceae ....."pine family"		
Picea sp. ....."spruce"	+	needle fragments: 2
Cupressaceae ...."cypress family"		
Juniperus communis L.	+	seed: 1
Typhaceae ....."cat-tail family"		
Typha sp.	+	seeds: 11
Unidentified plant taxa	+	seed: 1
Other:		
charcoal	+	'slivers'
charred leaf	+	
ANIMAL MACROFOSSILS:		
ARTHROPODA		
INSECTA	+	head: 1
EPHEMEROPTERA ..."mayflies"	+	larval mandibles: 2
HEMIPTERA ....."bugs"	+	pronotum: 1, heads: 3
Corixidae ....."water boatmen"	+	pronotum: 1, hemelytral fragment: 1
Saldidae ....."shore bugs"	+	head: 1
Saldula sp.	+	pronotum: 1
HOMOPTERA		
Cicadellidae ...."leafhoppers"	+	hemelytral fragments: 2, heads: 2
Psyllidae .... "jumping plant lice"	+	heads: 2
COLEOPTERA ....."beetles"	+	misc. fragments: sternites, articulated legs, elytral fragments
Carabidae ....."ground beetles"	+	pronotal fragment: 1, head: 1
Dyschiriodes	+	elytron: 1, articulated leg: 1
Bembidion sp.	+	heads: 2, pronotum: 1, elytron: 1
Tachys sp.	+	elytron: 1
Agonum sp.	+	pronotum: 1
Haliplidae? .."crawling water-beetles"	+	elytral fragment: 1
Dytiscidae ...."predaceous diving beetles"		
Colymbetes sp.	+	elytral fragments: 2
Hydrophilidae ..."water scavenger beetles"	+	pronota: 2, head: 2, elytral fragments: 2
Helophorus tuberculatus Gyll.	+	elytron: 1
Cercyon sp.	+	elytron: 1
Hydraenidae .."minute moss beetles"	+	half elytron: 1
Ochthebius sp.	+	elytra: 3, pronota: 2
Staphylinidae ..."rove beetles"	+	elytron: 1, head: 1, metasternum: 1
Bledini	+	head: 1
Omaliinae	+	head: 1, elytron: 1
Olophrum consimilie Gyll.	+	pronotum: 1
Olophrum sp.	+	elytra: 4, half pronotum: 1
Stenus sp.	+	elytron: 1
Lathrobium type	+	elytra: 2
Quedini	+	pronota: 2, head: 1
Aleocharinae	+	elytra: 3, pronotum: 1
Leiodidae ..."round fungus beetles"	+	elytron: 1
Helodidae ....."marsh beetles"	++	heads: 4, pronota: 6, elytra: 12, elytral fragments: 15
Lathridiidae ...."minute brown scavenger beetles"	+	elytra: 4, pronota: 2
Chrysomelidae ..."leaf beetles"	+	elytral fragment: 1
Gonioctena type	+	elytral fragments: 2
Curculionidae ..."weevils"	+	head: 1, pronotum: 1, elytral fragment: 1
Scolytidae ....."bark beetles"	+	head: 1
DIPTERA ....."flies"	+	thoraces: many
Chironomidae ...."midges"	+++	larval head capsules: 259
HYMENOPTERA .."wasps and ants"	+	ovipositor: 1, thoraces: 8
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	++	ephippia: 82
ARACHNIDA		
Araneae ....."spiders"	+	cephalothoraces: 2
Unidentifiable animal taxa	+++	egg capsules: (>100)
Other:		
bone	+	fragment: 1

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 250 microns (0.25 mm)

Marchand Point Series

A series of wood samples from the foreshore of the present beach south of Marchand Point on the eastern shore of the north basin of Lake Winnipeg, Manitoba (52°49'N, 97°22'W), at an elevation of 217.2 m, was collected by E. Nielsen on August 26, 1996. These samples were submitted by E. Nielsen to gain information on beach submergence in Lake Winnipeg, and lake level change.

BGS-1908 Marchand Point I

uncorrected age: 2050 ± 80

The wood sample (Marchand Point 96-1 (50 cm depth); *Larix*; identified by E. Nielsen), a tree stump rooted in calcareous sand, was submerged on the foreshore of the present beach with the root crown 50 cm below the level (217.7 m) of Lake Winnipeg.

BGS-1909 Marchand Point II

uncorrected age: 1100 ± 75

The wood sample (Marchand Point 96-2 (50 cm depth); *Larix*; identified by E. Nielsen), a tree stump rooted in calcareous sand, was submerged on the foreshore of the present beach with the root crown 50 cm below the level (217.7 m) of Lake Winnipeg, on day of collection.

Comments (E. Nielsen and D.L. Forbes): These dates were intended to help determine the rate of water-level rise in the northern basin of Lake Winnipeg, but are anomalously old, indicating that the sampled stumps were buried in an old fen which is now being exhumed by Lake Winnipeg shoreline erosion.

CAMS-38677 George Island

normalized age: 9170 ± 70

The ostracodes (*Candona rawsoni* Tressler; identified by C.G. Rodrigues) were enclosed in stiff weakly calcareous silty Lake Agassiz clay 31 cm below Lake Agassiz Unconformity at 124 cm. Core '96900 LW 207 PC' was collected by C.F.M. Lewis on August 26, 1996, from north of George Island in the north basin of Lake Winnipeg, Manitoba (52°51.6'N, 97°51.2'W), at an elevation of 217.7 m; water depth was 17.1 m; 3.34 m lake sediment recovered from 10 cm diameter piston core. This sample was submitted by C.F.M. Lewis to gain information on lake level change in Lake Winnipeg.

Assuming a $\delta^{13}C$ of -5‰, the age was normalized to a $\delta^{13}C$ of -25‰.

Stratigraphy: 3.34 m lake sediment (1.24 m Lake Winnipeg silty clay mud over 2.10 m Lake Agassiz silty clay) recovered with a 10 cm diameter by 9 m long piston corer in 17.1 m water depth. The dated ostracodes were from 0.31 m below the Lake Agassiz Unconformity (155-163 cm) in stiff, weakly calcareous, silty clay, rhythmically laminated below about 1.60 m down-core. The sample elevation of 198.5 m asl is based on acoustic profile and seismic reflection travel time to the Lake Agassiz Unconformity (Lewis et al., 2000).

Comments (A.M. Telka and C.F.M. Lewis): This age of 9.2 ka for ostracodes is the oldest date obtained in the Lake Winnipeg core series and provides an age for Lake Agassiz sediments below the unconformity at this point in the lake.

CAMS-35499 Grand Rapids

normalized age: 4800 ± 70

The charred spruce needles (*Picea*; identified by A.M. Telka) were enclosed in silty clay just above Lake Agassiz Unconformity, over stiff finely laminated silt-clay. Core '96900 LW 201 PC' was collected by C.F.M. Lewis on August 22, 1996, from about 13 km from Grand Rapids in the western north basin of Lake Winnipeg, Manitoba (53°12.0'N, 99°06.9'W), at an elevation of 217.8 m; water depth was 13.0 m; 5.25 m lake sediment recovered from 10 cm diameter piston core. This sample was submitted by C.F.M. Lewis to gain information on lake level change, and the Lake Agassiz Unconformity in northern Lake Winnipeg.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 5.25 m lake sediment (4.39 m Lake Winnipeg silt-clay mud over 0.86 m stiff, laminated, Lake Agassiz silty clay) recovered with a 10 cm diameter by 9 m long piston corer in 13.0 m water depth. The dated spruce needles (434-439 cm; 0.6 mg) were from basal Lake Winnipeg sediment immediately above an erosional contact, the Lake Agassiz Unconformity, which is underlain by stiff, finely laminated, silty clay with a dry, crumbly, blocky fractured character in upper 20 cm below the contact. The sample elevation of 199.5 m asl is based on acoustic profile and seismic reflection travel time to the Lake Agassiz Unconformity (Lewis et al., 2000).

Comments (A.M. Telka and C.F.M. Lewis): The preservational state of the spruce needle macrofossils was poor (two charred fragments and one was slightly charred) suggesting the needles were transported some distance prior deposition. The combined plant and insect macrofossil evidence suggest that the shoreline at 4.8 ka was no closer to the core site than it is today. Although this interval does not represent an *in situ* deposit, the dated spruce needles can be interpreted as representing an age for the beginning of Lake Winnipeg sedimentation over an erosional surface cut in Lake Agassiz sediment which was formerly exposed above lake level.

Fossil Arthropod and Plant Macrofossil Report: 97-01 (A.M. Telka)
Sample No.: 96900 Lake Winnipeg Core 201
Interval: 434-439 cm below water sediment interface
Laboratory No.: 2-56
Water Depth: 13.0 m
Material: silty clay mud
Sample Vol.: 80 mL (wet)

PLANT MACROFOSSILS:		
Vascular Plants:		
Pinaceae ....."pine family"		
Picea sp. ....."spruce"	+	needle fragments: 2, (one is charred)
Typhaceae....."cat-tail family"		
Typha sp.	+	seeds: 1.5
ANIMAL MACROFOSSILS:		
PORIFERA ....."sponges"		
HAPLOSCLERINA		
Spongillidae		
Spongilla type	++	
ARTHROPODA		
INSECTA		
COLEOPTERA ....."beetles"		
Staphylinidae ..."rove beetles"		
Aleocharinae	+	elytron: 1
Helodidae ....."marsh beetles"	+	elytron: 1, elytral fragment: 1
Lathridiidae ..."minute brown scavenger beetles"	+	elytron: 1
TRICHOPTERA ....."caddisflies"	+	larval frontoclypeal apotome: 1
DIPTERA ....."flies"		
Chironomidae ...."midges"	+	larval head capsules: 2.5
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	+	ephippia: 2
Ostracoda ....."ostracodes"	+	intact valves: 4, valves: 63
ARACHNIDA		
Araneae ....."spiders"	+	cephalothorax: 1
MOLLUSCA		
Gastropoda ....."snails, limpets"	+	7
Pelecypoda ....."clams, mussels"	+	intact valves: 11
Unidentifiable animal taxa	+	egg capsules: 18
Other:		
fish bone	+	fragment: 1

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 250 microns (0.25 mm)

Spider Islands Series

A series of wood samples from the foreshore of the modern beach on Spider Islands, on the northeastern shore of the north basin of Lake Winnipeg, Manitoba (53°30'N, 97°43'W), at an elevation of 217.7 m, was collected by E. Nielsen on August 25, 1996. These samples were submitted by E. Nielsen to gain information on beach submergence in Lake Winnipeg, and lake level change.

BGS-1906 Spider Islands I

uncorrected age: 390 ± 70

The wood sample (Spider Island 96-1; *Larix*; identified by E. Nielsen), a tree stump rooted in calcareous sand, was submerged on the foreshore of the present beach with its root crown at about the same elevation as Lake Winnipeg water level, on the day of collection.

BGS-1907 Spider Islands II

uncorrected age: 255 ± 75

The wood sample (Spider Island 96-2; *Larix*; identified by E. Nielsen), a tree stump rooted in calcareous sand, was submerged on the foreshore of the present beach with its root crown at about the same elevation as the water level in Lake Winnipeg.

Comment (E. Nielsen): These dates will help determine the rate of water-level rise in Lake Winnipeg.

CAMS-38676 Warren Landing

normalized age: 6700 ± 80

The ostracodes (*Candona rawsoni* Tressler and *C. subtriangulata*; identified by C.G. Rodrigues) were enclosed in calcareous silty clay mud under clay mud (Lake Winnipeg sediments). Core '96900 LW 204 PC' was collected by C.F.M. Lewis on August 24, 1996, from about 20 km from Warren Landing on the northeastern shore of the north basin of Lake Winnipeg, Manitoba (53°34.0'N, 98°06.3'W), at an elevation of 217.8 m; water depth was 15.9 m; 5.79 m lake sediment recovered from 10 cm diameter piston core. This sample was submitted by C.F.M. Lewis to gain information on lake level change, and Lake Winnipeg sediments.

Assuming a $\delta^{13}C$ of -5‰, the age was normalized to a $\delta^{13}C$ of-25‰.

Stratigraphy: 5.79 m Lake Winnipeg sediment recovered with a 10 cm diameter by 9 m long piston corer in 15.9 m water depth. The dated ostracode interval (362-373 cm) was within a unit of soft, calcareous, silty clay mud with occasional sharp-based laminae of silt and fine sand, conformably overlain by 3.30 m of soft clay mud. Because this core did not penetrate a sharp unconformity with underlying Lake Agassiz sediments, the sample elevation of 198.2 m asl is based on lake level at the time of coring, water depth, and depth in core.

Comments (A.M. Telka and D.L. Forbes): The dated ostracodes were from calcareous silty clay mud and susceptible to 'hardwater' effects from old carbon within the watershed and are likely a few hundred years younger than the age determined here. These dates on early Lake Winnipeg sediments in core '204' are reasonably consistent with the date of 6.9 ka on similar ostracodes (*Candona rawsoni* and *C. subtriangulata*) in a coarse-grained basal unit of Lake Winnipeg sediments in nearby core '106' (see CAMS-38675, below).

CAMS-38678 Warren Landing

normalized age: 6750 ± 70

The spruce needle (*Picea*; identified by A.M. Telka) was enclosed in Lake Winnipeg calcareous mud and silt laminations under clay mud. Core '96900 LW 204 PC' was collected by C.F.M. Lewis on August 24, 1996, from about 20 km from Warren Landing on the northeastern shore of the north basin of Lake Winnipeg, Manitoba (53°34.0'N, 98°06.3'W), at an elevation of 217.8 m; water depth was 15.9 m; 5.79 m lake sediment recovered from 10 cm diameter piston core. This sample was submitted by C.F.M. Lewis to gain information on lake level change, and Lake Winnipeg sediments.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 5.79 m Lake Winnipeg sediment recovered with a 10 cm diameter by 9 m long piston corer in 15.9 m water depth. The dated spruce needle (513-518 cm) was within a unit of soft, calcareous, silty clay mud with occasional sharp-based laminae of silt and fine sand, conformably overlain by 3.30 m of soft clay mud. Because this core did not penetrate a sharp unconformity with underlying Lake Agassiz sediments, the sample elevation of 196.8 m asl is based on the lake level at the time of coring, water depth, and depth in the core.

Comments (A.M. Telka): The preservational state of spruce (*Picea*) needle fragment (5.5 mm length) was poor. This partially charred fragment had neither base nor tip, suggesting long-distance transport before final deposition. Plant macrofossils in this sample were rare with only one well preserved cat-tail (*Typha*) seed, a charred moss fragment and the dated spruce needle fragment. Insect fossils were also rare with minimal representation of shoreline type insects. The shoreline at 6.8 ka was probably not significantly nearer than it is today.

Fossil Arthropod and Plant Macrofossil Report: 97-03 (A.M. Telka)

Sample No.: 96900 Lake Winnipeg Core 204
Interval: 513-518 cm below water sediment interface
Laboratory No.: 2-48
Water Depth: 15.9 m
Material: soft, calcareous, silty clay mud
Sample Vol.: 90 mL (wet)

PLANT MACROFOSSILS:		
Non Vascular Plants:		
Bryophytes ....."mosses"	+	fragments: 2 (one is charred)
Vascular Plants:		
Pinaceae ....."pine family"		
Picea sp. ....."spruce"	+	needle fragment: 1 (slightly charred)
Typhaceae....."cat-tail family"		
Typha sp.	+	seed: 1 (well preserved)
Other:		
charred organics	+	fragment: 1
ANIMAL MACROFOSSILS:		
BRYOZOA		
Cristatella mucedo L.	+	statoblasts: 3
ARTHROPODA		
INSECTA		
COLEOPTERA ....."beetles"	+	misc. fragments
Carabidae ....."ground beetles"		
Bembidion sp.	+	elytral fragment: 1
Hydraenidae ..."minute moss beetles"		
Ochthebius sp.	+	half elytron: 1
Staphylinidae ..."rove beetles"	+	elytron: 1
Aleocharinae	+	pronotum: 1, elytron: 1, head: 1
Helodidae ....."marsh beetles"	+	pronotum: 1, elytral fragment: 1
DIPTERA ....."flies"	+	thoraces: 5
Chironomidae ...."midges"	+	larval head capsules: 5

HYMENOPTERA ....."wasps and ants"		
Ichneumonoidea .."ichneumons and braconids"	+	head: 1
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	+	ephippia: 15
Ostracoda ....."ostracodes"	+	valves: 23
Unidentifiable animal taxa	+	egg cases: 18

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 250 microns (0.25 mm)

CAMS-32191 Warren Landing

normalized age: 6910 ± 200

The macrofossils, ostracodes (*Candona rawsoni* and *C. subtriangulata*; identified by C.G. Rodrigues) were enclosed in basal, moderately calcareous clay-silt directly overlying the Lake Agassiz Unconformity. Core '94900 LW 106 PC' was collected by C.F.M. Lewis on August 23, 1994, from about 20 km from Warren Landing on the northeastern shore of the north basin of Lake Winnipeg, Manitoba (53°34.70'N, 98°05.83'W), at an elevation of 217.6 m; water depth was 16.8 m; 7.89 m lake sediment recovered from 10 cm diameter piston core. This sample was submitted by C.F.M. Lewis to gain information on lake level change in Lake Winnipeg, and Lake Agassiz drainage.

Assuming a $\delta^{13}C$ of -7‰, the age was normalized to a $\delta^{13}C$ of -25‰.

Stratigraphy: 7.89 m lake sediment (182 cm of Lake Winnipeg mud over 607 cm of Lake Agassiz sediments) recovered with a 10 cm diameter by 9 m long piston corer in 16.8 m water depth. The dated ostracodes (176-182 cm) were from 0 to 6 cm above the Lake Agassiz Unconformity in a 23 cm-thick unit of soft, moderately calcareous, clay-silt mud with silt and sand, directly overlying erosional contact with the underlying firm silty clay rhythmites deposited in Lake Agassiz. The sample elevation of 198.9 m asl is based on acoustic profile and seismic reflection travel time to the Lake Agassiz Unconformity (Lewis et al., 2000).

Comments (C.F.M. Lewis): Some of the sample gas was lost during sample analysis, hence the relatively large error estimate, yet the date of 6.9 ka provides an age estimate for the basal coarse facies of Lake Winnipeg sediment. This age determination on biogenic carbonate is not corrected for 'hardwater' error and could therefore be several hundred years too old.

CAMS-38675 Warren Landing

normalized age: 6900 ± 80

The ostracodes (*Candona rawsoni* Tressler and *C. subtriangulata*; identified by C.G. Rodrigues) were enclosed in moderately calcareous clay-silt mud at erosional contact on silty clay rhythmites. Core '94900 LW 106 PC' was collected by C.F.M. Lewis on August 23, 1994, about 20 km from Warren Landing on the northeastern shore of the north basin of Lake Winnipeg, Manitoba (53°34.70'N, 98°05.83'W), at an elevation of 217.6 m; water depth was 16.8 m; 7.89 m lake sediment recovered from 10 cm diameter piston core. This sample was submitted by C.F.M. Lewis to gain information on lake level change in Lake Winnipeg, and Lake Agassiz drainage.

Assuming a $\delta^{13}C$ of -5‰, the age was normalized to a $\delta^{13}C$ of -25‰.

Stratigraphy: 7.89 m lake sediment (182 cm of Lake Winnipeg mud over 607 cm of Lake Agassiz sediments) recovered with a 10 cm diameter by 9 m long piston corer in 16.8 m water depth. The dated ostracodes (174-179 cm) were from 3 to 8 cm above the Lake Agassiz Unconformity in a 23 cm-thick unit of soft, moderately calcareous, clay-silt mud with silt and sand, directly overlying erosional contact with the underlying firm silty clay rhythmites deposited in Lake Agassiz. The sample elevation of 199.0 m asl is based on acoustic profile and seismic reflection travel time to the Lake Agassiz Unconformity (Lewis et al., 2000).

Comments (A.M. Telka and C.F.M. Lewis): This was a replicate sample of CAMS-32191 and was dated to reduce the large uncertainty in the original date. The date of 6.9 ka provides an age estimate for the basal coarse facies of Lake Winnipeg sediment in the northeast north basin of the lake.

Pollen stratigraphy in the north basin of Lake Winnipeg

by T.W. Anderson and R.E. Vance
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Introduction:

Samples from three piston cores (C-103, -106, -105) recovered from offshore sediments in the north basin of Lake Winnipeg were processed to, i) derive a composite pollen stratigraphy for Lake Winnipeg and underlying Lake Agassiz sediments and to correlate this pollen stratigraphy with dated pollen records on land, ii) to determine vegetation and climate history for the basin as a whole and iii) to determine evidence for and timing of Lake Agassiz and Lake Winnipeg deposition and associated lake level changes. Samples for pollen analysis were extracted from the cores and forwarded to the authors by the project leaders.

Palynological Methods:

The sediment samples were treated using standard palynological methods (Faegri and Iversen, 1975) including acid digestion, acetolysis and suspension in silicone oil. Exotic pollen was added prior to treatment and these were counted along with the fossil pollen to determine overall pollen / spore concentrations / cc of sediment. The processed sediment was sieved according to the method of Cwynar et al (1979) to concentrate the fossil pollen. The pollen sum averaged between 220-350 tree, shrub and herb pollen which served as the basis upon which pollen percentages were calculated. The composite pollen diagrams show analyses done on the entire length of Core '103' and on segments of Cores '106' (4 to 7 m) and '105' (2 to 5 m). The pollen stratigraphy is zoned into five pollen assemblage zones based on the pollen changes.

Chronology:

Alternate chronologies were derived for the Lake Winnipeg basin sediments by correlating the pollen Zones with similar-dated pollen Zones in reference pollen diagrams at Riding Mountain (Ritchie, 1964) and Grand Rapids (Ritchie and Hadden, 1975). Using dates for the *Picea* (spruce) maxima and pollen Zone boundaries common to the reference pollen diagrams (10 000, 6000 and 2500 BP for the basal *Picea* peak and Zone boundaries III/II and II/I, respectively, at Riding Mountain and 7220, 6000 and 4000 BP for the basal *Picea* peak and Zone boundaries III/II and II/I, respectively, at Grand Rapids), time scales (thousands of years BP) were placed on the Lake Winnipeg record by assuming uniform rates of sedimentation between the dated levels. The chronologies are similar in mid Holocene time, particularly at 6000 BP, but differ in the early and late Holocene. The Riding Mountain record provides a better correlation for the early Lake Agassiz history as the Grand Rapids record commences late in Lake Agassiz time. A comparison with Riding Mountain shows the Lake Agassiz stratigraphy may be older by as much as 2880 years than that derived from a similar comparison

with Grand Rapids. The late Holocene spruce return (Zone II/I boundary) occurred earlier by as mucn as 1200 years at the more northern Grand Rapids site.

Interpreted Vegetation History:

The pollen assemblage Zones are interpreted in terms of vegetation composition from known, existing analogue situations. The lowest assemblage Zones 5 and 4 contain a mixture of spruce, pine, birch and willow and taxa within the grasses, chenopods and composites. The hardwood pollen of oak and elm were probably blown into the lake from distant sources to the south. The initial vegetation probably resembled a spruce parkland with treeless areas that were occupied by sagebrush, ragweed, grasses, chenopods and other prairie herbs. Zone 5 with high *Artemisia* (up to 36%) and occurrences of *Oxyria digyna* at the base of the rhythmites just above till might be interpreted as being more tundra-like. An age of 7450 BP is inferred for the 425 cm level in C-105 based on a comparison with projected rates of sedimentation in the Grand Rapids record. The 10 000 BP and 7220 BP estimates for the basal spruce maximum at Riding Mountain and Grand Rapids sites, respectively, fall within the same spruce maximum in C-106 at about the 575 cm level. Spruce was probably more widespread around the north basin at these respective times than at any time previously. The overlying Zone 3 shows minimum spruce and a dominance of grassland taxa such as grasses, chenopods, *Ambrosia* and *Artemisia*. The vegetation shows an abrupt change across the Zone 4/3 boundary from spruce parkland to primarily grassland. Comparison with both Riding Mountain and Grand Rapids shows the Zone 3/2 boundary is marked by a sharp change at about 6000 BP from dominance of grassland taxa to notable increases in pine, alder and poplar and in the alga *Pediastrum*. The abrupt pollen change and sudden influx of *Pediastrum* across the 3/2 boundary corresponds with the sediment change from Lake Agassiz to Lake Winnipeg deposition. The pollen change indicates an unconformable sequence and there is a high probability that some of the sediment record is missing at the contact between the Lake Agassiz and overlying Lake Winnipeg sediments in C-103. The vegetation of Zone 2 time comprised a mixed forest of spruce, pine, alder, poplar with birch and willow. In Zone 1 pine is at its maximum and spruce reappears again as a dominant component in the local forest. Since about 4000 BP and 2500 BP (comparison with Grand Rapids and Riding Mountain sites, respectively) the vegetation was probably not unlike the modern-day Boreal Forest in the area.

Climatic Deductions:

The large expanse of Lake Agassiz may have generated a local, cool climate (Anderson and Lewis, 1992) which would have favoured spruce parkland vegetation in areas bordering the north basin during Zones 5 and 4 time. The spruce dominance suggests the climate had become warmer as early as 10 000 BP or as late as 7200 BP. The switch to grassland around 9 ka at Riding Mountain and after 7.2 ka at Grand Rapids represents an expansion of grassland eastward to the Lake Winnipeg basin. The period of grassland dominance corresponds to the early Holocene interval of increased aridity when mean annual temperatures may have exceeded current conditions by 0.5° to 1.5°C to as much as 3°C and mean annual precipitation was reduced by 65 mm to as much as 50 mm below present values (Vance et al., 1995). The period of maximum warmth and dryness and corresponding increase in evapotranspiration rates caused many lakes in the southern Prairie region to dry up completely and others to become hypersaline playas (Vance et al., 1995; 1997). Grassland dominated everywhere until about 6000 BP when it was invaded by forest. Climatic conditions deteriorated gradually after 6000 BP and more so after 4000 BP and 2500 BP (comparisons with the records at Riding Mountain and Grand Rapids, respectively) with the change from mixed forest to more boreal conditions. The onset of the late Holocene cooler / wetter climate was accompanied by gradually to rapidly rising lake levels in the southern Prairies; for most sites, lake levels fluctuated but never reached the low-water episodes of the middle Holocene (Vance et al., 1993; 1997).

CAMS-32189 Warren Landing

normalized age: 7700 ± 50

The unidentified twigs were enclosed in clay-silt mud and silty fine sand overlain by clay-silt mud. Core '94900 LW 104a GC' was collected by C.F.M. Lewis on August 23, 1994, from about 20 km from Warren Landing on the northeastern shore of the north basin of Lake Winnipeg, Manitoba (53°35.05'N, 98°05.11'W), at an elevation of 217.7 m; water depth was 16.2 m; 3.65 m lake sediment recovered from 10 cm diameter gravity core. This sample was submitted by C.F.M. Lewis to gain information on lake level change, and Lake Winnipeg sediments.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: 3.65 m of Lake Winnipeg sediment recovered with a 10 cm diameter by 9 m long gravity corer in 16.2 m water depth. The dated twigs (237-243 cm) were from 7 to 13 cm below the base of clay silt mud in a basal 135 cm-thick unit of interlaminated clay-silt mud and silty fine sand. The sample elevation 199.8 m asl is based on acoustic profile and seismic reflection travel time to the base of the mud (Lewis et al., 2000).

Comments (A.M. Telka and C.F.M. Lewis): The preservation of the two barkless twig fragments was fair, suggesting these twigs have been redeposited. The 7.7 ka age is the oldest date obtained on Lake Winnipeg sediments. The macrofossil assemblage typifies a marsh environment of mostly cat-tail (*Typha*) with predominantly shoreline insect taxa of marsh (Helodidae) beetles, suggesting that the shoreline was close to the core site at the time of deposition. The lack of plant macrofossils of tree species within this sample further supports the interpretation that the dated twigs may be reworked.

Fossil Arthropod and Plant Macrofossil Report: 96-18 (A.M. Telka)

Sample No.:	94900 Lake Winnipeg Core 104a
Interval:	237-243 cm below water sediment interface
Laboratory No.:	1-135.5
Water Depth:	16.2 m
Material:	clay-silt mud and silty fine sand
Sample Vol.:	100 mL (wet)

PLANT MACROFOSSILS:		
Vascular Plants:		
Pinaceae ....."pine family"		
Pinus? sp. ....."pine"	+	needle fragment-charred, poorly preserved
Typhaceae ....."cat-tail family"		
Typha sp.	++	seeds: 9
Chenopodiaceae .."goosefoot family"		
Chenopodium sp.	+	seed: 1
Rosaceae ....."rose family"		
Rubus idaeus L.	+	seed fragment: 1
Other:		
wood	+	twig fragments: 2 (no outer bark)
charcoal	+	'slivers'
ANIMAL MACROFOSSILS:		
HIRUDINEA ....."leeches"	+	cocoons :10
ARTHROPODA		
INSECTA		
HEMIPTERA ....."bugs"	+	head: 1

Saldidae ....."shore bugs"	+	hemelytral fragment: 1, head: 1
COLEOPTERA ....."beetles"		
Carabidae ....."ground beetles"		
Elaphrus fuliginosus? Say	+	head fragment: 1
Hydrophilidae ..."water scavenger beetles"	+	elytral fragments: 2, head fragment: 1
Helophorus sp.	+	left elytron: 1
Hydraenidae .."minute moss beetles"		
Ochthebius sp.	+	right and left elytra: 2
Staphylinidae ..."rove beetles"		
Aleocharinae	+	elytron: 1
Helodidae ....."marsh beetles"	++	heads: 2, elytra: 4, half elytra/fragments: 12
Chrysomelidae ..."leaf beetles"	+	head: 1
Bromus? sp.	+	elytral fragment: 1
DIPTERA ....."flies"		
Chironomidae ...."midges"	++	larval head capsules
CRUSTACEA		
Ostracoda ....."ostracodes"	++	valves (>100)
MOLLUSCA		
Gastropoda ....."snails, limpets"	+	fragments
Pelecypoda ....."clams, mussels"	+	valves, fragments

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 250 microns (0.25 mm)

CAMS-32192 off northern shore

normalized age: 6810 ± 60

The ostracodes (*Candona rawsoni* and *C. subtriangulata*; identified by C.G. Rodrigues) were enclosed in the base of a silt mud unit, overlying soft laminated calcareous clay. Core '96900 LW 202 PC' was collected by C.F.M. Lewis on August 23, 1996, from about 16 km from the northern shoreline in the north basin of Lake Winnipeg, Manitoba (53°43.2'N, 98°36.2'W), at an elevation of 217.8 m; water depth was 13.6 m; 5.79 m lake sediment recovered from 10 cm diameter piston core. This sample was submitted by C.F.M. Lewis to gain information on the northerly offshore limit of the Lake Agassiz Unconformity, and lake level change in Lake Winnipeg.

Assuming a $\delta^{13}C$ of -7‰, the age was normalized to a $\delta^{13}C$ of -25‰.

Stratigraphy: 5.79 m lake sediment recovered with a 10 cm diameter by 9 m long piston corer in 13.6 m water depth. The dated ostracodes (174-179 cm) were at the base of a basal Lake Winnipeg clayey silt mud unit (116-179 cm), immediately over the Lake Agassiz Unconformity, underlain by soft to firm, laminated, calcareous Lake Agassiz clay (179-341 cm). The sample elevation of 203.4 m asl is based on acoustic profile and seismic reflection travel time to the Lake Agassiz Unconformity (Lewis et al., 2000).

Comments (A.M. Telka and C.F.M. Lewis): This site is the most northerly dated in the Lake Winnipeg series and provides an age estimate of 6.8 ka for the beginning of Lake Winnipeg sedimentation over the Lake Agassiz Unconformity. The date may be anomalously old (by several hundred years) due to undetermined 'hard-water' error. Insect fossils within this sample were minimally represented by both aquatic and shoreline types. Plant macrofossils were non-existent except for a few charred fragments of wood. The lack of shoreline indicators from the combined fossil evidence suggests shoreline at 6.8 ka was probably not significantly closer to the core site than it is today.

Fossil Arthropod and Plant Macrofossil Report: 97-02 (A.M. Telka)
Sample No.: 96900 Lake Winnipeg Core 202
Interval: 174-179 cm below water sediment interface
Laboratory No.: 2-47
Water Depth: 13.6 m
Material: calcareous clayey silt mud
Sample Vol,: 80 mL (wet)

PLANT MACROFOSSILS:		
Unidentified plant taxa	+	capsule: 1
Other:		
charred wood	+	small fragments: 3
ANIMAL MACROFOSSILS:		
ARTHROPODA		
INSECTA		
HEMIPTERA ....."bugs"	+	pronotum: 1
Corixidae ....."water boatmen"	+	hemelytral fragment: 1
COLEOPTERA ....."beetles"	+	half elytron: 1
Staphylinidae ..."rove beetles"		
Olophrum sp.	+	elytron: 1
Aleocharinae	+	pronotum: 1
Helodidae ....."marsh beetles"	+	half elytra: 2, half pronotum: 1
Chrysomelidae ..."leaf beetles"		
Gonioctena type	+	elytron: 1
LEPIDOPTERA? .."butterflies/moths	+	head capsule: 1
DIPTERA ....."flies"	+	thorax and abdomen: 1
Chironomidae ...."midges"	+	larval head capsules: 8
HYMENOPTERA ..."wasps and ants"		
Ichneumonoidea .."ichneumons and braconids"	+	thorax and abdomen: 3
CRUSTACEA		
Cladocera ....."water fleas"		
Daphnia sp.	+	ephippia: 1
Ostracoda ....."ostracodes"	++	intact valves: 5, valves: about 150
MOLLUSCA		
Gastropoda ....."snails, limpets"	+	whole: 3, many fragments
Pelecypoda? ....."clams, mussels"	+	shell fragment: 1
Unidentifiable animal taxa	+	capsules: 63
Other:		
fish scale	+	1

Key: + = taxon present, +++ = taxon is abundant
- based upon examination of organics greater than 250 microns (0.25 mm)

CAMS-34553 Limestone Bay

normalized age: 930 ± 90

The cinquefoil seeds (*Potentilla norvegica* L.; identified by A.M. Telka) were enclosed in peaty mud overlying poorly sorted medium silty sand. Core '94307-003' was collected by D.L. Forbes and D. Frobel on September 8, 1994, near the head of Limestone Bay behind the northwest shore in the north basin of Lake Winnipeg, Manitoba (53°49.9'N, 98°42.5'W), at an elevation of 217.3 m. This sample was submitted by D.L. Forbes to gain information on the beach ridge and beach ridge formation, and lake level change in Lake Winnipeg.

The age was normalized assuming a $\delta^{13}C$ of -25‰.

Stratigraphy: A 1.00-m Hiller core was comprised of muddy peat (0-38 cm) and organic-rich silty mud (38-81 cm) overlying poorly sorted silty medium sand.

Comments (A.M. Telka and D.L. Forbes): This date of 0.9 ka on cinquefoil (*Potentilla norvegica*) seeds from near the base of a firm organic-rich mud unit (7[illegible]) provides a minimum age for the inner part of the beach-ridge complex, represented by the sand at the base of the core, and for early growth of the Limestone Point spit (Forbes, 2000). The plant and insect macrofossil assemblage from this dated interval is typical of a shoreline environment with abundant cat-tail (*Typha*), many species of sedges (*Carex*), cinquefoil (*Potentilla norvegica* L.) and mosses (*Sphagnum*), as well as insects that live near water including ground beetles (*Bembidion*) and rove beetles (Staphylinidae).

Fossil Arthropod and Plant Macrofossil Report: 98-01 (A.M. Telka)
Sample No.: 94307-003
Interval: 70-79 cm
Laboratory No.: 2-17
Material: peaty mud
Sample Vol.: 34 mL

PLANT MACROFOSSILS:	
Fungal Remains:	
fungal sclerotia	+ 2
Non Vascular Plants:	
Bryophytes ....."mosses"	+ few stems with leaves
Sphagnum sp.	+
Vascular Plants:	
Pinaceae ....."pine family"	+ seeds: 2
Picea sp.	+ needle fragment: 1 (charred)
Typhaceae ....."cat-tail family"	
Typha sp.	+ seeds: 2
Gramineae ....."grass family"	+ seeds: 2
Cyperaceae ....."sedge family"	
Carex trigonous type	+ seeds: 4 (with perigynum)
Carex lenticular type	+ seeds: 12
Eleocharis sp.	+ seeds: 7
Eleocharis palustris (L.) R. and S.	+ seed: 1
Caryophyllaceae? "pink family"	+ seed fragment: 1
Ranunculaceae ..."crowfoot family"	
Ranunculus sceleratus L.	+ seed: 1
Rosaceae ....."rose family"	
Potentilla norvegica L.	++ seeds: 21, seed fragments: 3
Potentilla sp.	+ seeds: 5
Ericaceae ....."heath family"	
Chamaedaphne calyculata (L.) Moench.	+ seed: 1
Labiatae ....."mint family"	
Mentha sp.	+ seeds: 2
Compositae ...."composite family"	+ seed: 1
Unidentified plant taxa	+ seed fragments: 5
Other:	
wood	+ fragments
net-veined leaves	+ fragments: 3
ANIMAL MACROFOSSILS:	
PORIFERA ....."sponges"	
HAPLOSCLERINA	
Spongillidae	
Spongilla type	+ 3-cell clusters: 9
BRYOZOA	
Cristatella mucedo L.	+ statoblasts: 3
Plumatella type	+ statoblasts: 1
ARTHROPODA	
INSECTA	
COLEOPTERA ....."beetles"	+ pronotal fragment: 1, sternite: 1
Carabidae ....."ground beetles"	
Bembidion sp.	+ elytra: 2
Staphylinidae ..."rove beetles"	+ elytron: 1
Aleocharinae	+ elytra: 2
Curculionidae ..."weevils"	
Rhynchaenus sp.	+ head: 1
LEPIDOPTERA ..."butterflies/moths"	+ larval head capsules: 2
DIPTERA ....."flies"	+ puparia: 1
Chironomidae ...."midges"	+ larval head capsules: 10
CRUSTACEA	
Cladocera ....."water fleas"	
Daphnia sp.	+ ephippia: 17
ARACHNIDA	
Oribatei/Acari ..."mites"	+ 5
Unidentifiable animal taxa	+ immature mandible: 1

Key: + = taxon present, ++ = taxon is abundant;
- based upon examination of organics greater than 250 microns (0.25 mm)

Radiocarbon Dates related to Lake Winnipegosis

Beta-68085 Lake Winnipegosis I

normalized age:	350 ± 60
	$\delta^{13}C$= -0.7‰
uncorrected:	modern

The freshwater shells (*Stagnicola*; identified by G.E. Tackman) were enclosed in the top of an organic bed (marsh / lagoon) overlain by 0.3 m (1 ft) of pebbly coarse sand. Sample '28-2.1' was collected by G.E. Tackman and D. Currey near Thorsteinson Creek, southern Lake Winnipegosis, Manitoba (51.718°N, 99.986°W), at an elevation of 255.3 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level 1, of Lake Winnipegosis, and postglacial rebound.

The calibrated age is 1553 AD (1455 AD - 1645 AD).

Beta-68075 Lake Winnipegosis II

normalized age:	220 ± 70
	$\delta^{13}C$= -3.9‰
uncorrected:	modern

The freshwater shells (*Lampsilis radiata*; identified by G.E. Tackman) were enclosed in beach crest sediments. Sample '24-6.1' was collected from small excavations in the beach crest by G.E. Tackman and D. Currey near Salt Point, southern Lake Winnipegosis, Manitoba (51.741°N, 99.809°W), at an elevation of 254.8 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level 1, of Lake Winnipegosis, and postglacial rebound.

The calibrated age is 1665 AD (1645 AD - modern)

Beta-68073 Lake Winnipegosis III

normalized age:	410 ± 80
	$\delta^{13}C$= -3.9‰
uncorrected age:	70 ± 80

The freshwater shells (*Lampsilis radiata*; identified by G.E. Tackman) were enclosed in beach crest sediments. Sample '24-4.1' was collected from a shallow excavation in the beach crest by G.E. Tackman and D. Currey from Salt Point, southern Lake Winnipegosis, Manitoba (51.755°N, 99.814°W), at an elevation of 254.8 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level 1, of Lake Winnipegosis, and postglacial rebound.

The calibrated age is 1455 AD (1430 AD - 1560 AD).

Beta-68089 Lake Winnipegosis IV

normalized age: 110 ± 60
$\delta^{13}C$= -26.6‰
uncorrected age: 140 ± 60

The peat was enclosed in a 5 cm-thick bed of dark brown fibrous peat overlain by 0.3 m (1 ft) of pebbly coarse sand. Sample '27-5.1' was collected by G.E. Tackman and D. Currey near Sucker Point, southern Lake Winnipegosis, Manitoba (51.809°N, 99.910°W), at an elevation of 254.8 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level 1, of Lake Winnipegosis, and postglacial rebound.

The calibrated age is modern (1680 AD - modern).

These dates provide a maximum age for level 1.

Petes Point Series

A series of freshwater shell samples from near Petes Point, southern Lake Winnipegosis, Manitoba (51.857°N, 100.112°W), at an elevation of 254.7 m, was collected by G.E. Tackman and D. Currey. These samples were submitted by G.E. Tackman to gain information on the beach crest, level 1, of Lake Winnipegosis, and postglacial rebound.

Beta-77523 Lake Winnipegosis V

normalized age: 460 ± 100
$\delta^{13}C$= -5.3‰
uncorrected age: 140 ± 100

The freshwater shells (*Lampsilis radiata*; identified by G.E. Tackman) of sample '402-2.1' from 0.8 m depth in lower foreshore were enclosed in pebbly gravel over clean marsh peat and under clean fine sand with shell fragments.

The calibrated age is 1440 AD (1410 AD - 1620 AD).

The date provides a maximum age for level 1. Consult Beta-68072 (p. 58) in the section on 'Lake Manitoba' for additional comments.

Beta-77524 Lake Winnipegosis VI

normalized age: 420 ± 40
$\delta^{13}C$= -28.7‰
uncorrected age: 480 ± 40

The marsh peat sample from 0.85 m depth was just below the clean pebbly gravel.

The calibrated age is 1455 AD (1440 AD - 1485 AD).

The date provides a maximum age for level 1. Consult Beta-68072 (p. 58) in the section on 'Lake Manitoba' for additional comments.

Smoky Island Bay Series

A series of freshwater shell samples from near Smoky Island Bay, southern Lake Winnipegosis, Manitoba (52.062°N, 100.158°W), at an elevation of 254.2 m, was collected by G.E. Tackman and D. Currey. These samples were submitted by G.E. Tackman to gain information on the beach crest, level 1, of Lake Winnipegosis, and postglacial rebound.

Beta-68105 (AMS) Lake Winnipegosis VII

normalized age: 590 ± 60
$\delta^{13}C$= -5.0‰
uncorrected age: 260 ± 60

The freshwater shells (*Stagnicola*; identified by G.E. Tackman) of sample '28-6.2f' were enclosed in the top of a woody peat and overlain by 0.4 m of clean medium-grained beach sand.

The calibrated age is 1400 AD (1305 AD - 1415 AD).

The date provides a maximum, limiting age for the beach crest, although it suggests a 'hardwater' effect (cf. Beta-68102). Consult Beta-68072 (p. 58) in the section on 'Lake Manitoba' for additional comments.

Beta-68102 (AMS) Lake Winnipegosis VIII

normalized age: 300 ± 90
$\delta^{13}C$= -25.7‰
uncorrected age: 310 ± 90

The charred wood of sample '28-6.2' was enclosed in the top of woody peat overlain by 0.4 m of clean medium-grained beach sand.

The calibrated age is 1645 AD (1480 AD - 1790 AD).

The date provides a maximum, limiting age for the beach crest. Consult Beta-68072 (p. 58) in the section on 'Lake Manitoba' for additional comments.

Beta-68107 Lake Winnipegosis IX

normalized age: 3100 ± 110
$\delta^{13}C$= -2.8‰
uncorrected age: 2730 ± 100

The freshwater shells (*Stagnicola*; identified by G.E. Tackman) were enclosed in the top of a pebbly organic bed overlain by 0.6 m of pebbly medium to coarse-grained sand. Sample '29-1.1' was collected by G.E. Tackman and D. Currey near Smoky Island Bay, southern Lake Winnipegosis, Manitoba (52.063°N, 100.161°W), at an elevation of 255.1 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level 4, of Lake Winnipegosis, and postglacial rebound.

The calibrated age is 1490 BC (1520 BC - 1230 BC).

Beta-68100 (AMS) Lake Winnipegosis X

normalized age: 1510 ± 60
$\delta^{13}C$= -6.4‰
uncorrected age: 1200 ± 60

The freshwater shells (*Lampsilis radiata*; identified by G.E. Tackman) were a surface collection from rodent burrows in beach crest. Sample '3-1.7' was collected by G.E. Tackman and D. Currey near Sclater River, central Lake Winnipegosis, Manitoba (52.110°N, 100.409°W), at an elevation of 256.3 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level 3, of Lake Winnipegosis, and postglacial rebound.

The calibrated age is 570 AD (540 AD - 630 AD).

Beta-68104 (AMS) Lake Winnipegosis XI

normalized age: 5290 ± 60
$\delta^{13}C$= -3.3‰
uncorrected age: 4930 ± 60

The large freshwater shell (*Stagnicola*; identified by G.E. Tackman) was enclosed in the top of 0.8 m of fossiliferous deltaic sand, over 0.6 m sand with interbedded dark grey clay. Sample '31-1.1f' was collected by G.E. Tackman and D. Currey near East Favel River, Dauphin Lake, Manitoba (52.139°N, 101.089°W), at an elevation of 254.5 m. This sample was submitted by G.E. Tackman to gain information on the shoreline, Dawson level, of Lake Winnipegosis, and postglacial rebound.

The calibrated age is 4090 BC (4170 BC - 4000 BC).

This sample is associated with earlier Dawson level, and dates a minimum elevation for lake level.

Beta-68113 (AMS) Lake Winnipegosis XII

normalized age: 1070 ± 90
$\delta^{13}C$= -4.1‰
uncorrected age: 730 ± 90

The freshwater shells (*Lampsilis radiata*; identified by G.E. Tackman) were enclosed in stratified beach gravel. Sample '29-2.1' was collected by G.E. Tackman and D. Currey in a backhoe excavation at Camilles Point, central Lake Winnipegosis, Manitoba (52.161°N, 100.139°W), at an elevation of 255.2 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level 2, of Lake Winnipegosis, and postglacial rebound.

The calibrated age is 990 AD (890 AD - 1030 AD).

The date provides a maximum, limiting age for the beach crest, i.e. a maximum age for level 2.

Beta-98794 (AMS) Lake Winnipegosis XIII

normalized age: 5600 ± 60

The freshwater shells (*Marstonia gelida*; identified by G.E. Tackman) were enclosed in beach crest sediments. Sample '601-1.6' was collected by G.E. Tackman and D. Currey near Staple Island Bay, central Lake Winnipegosis, Manitoba (52.523°N, 100.022°W), at an elevation of 257.4 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, pre-Dawson level, of Lake Winnipegosis, and postglacial rebound.

The age was normalized to a $\delta^{13}C$ of -25‰.

Beta-98793 Lake Winnipegosis XIV

normalized age: 5830 ± 110
$\delta^{13}C$= +0.1‰
uncorrected age: 5410 ± 100

The freshwater shells (*Marstonia gelida*; identified by G.E. Tackman) were enclosed in beach crest pebbly medium sand. Sample '601-1.7' was collected by G.E. Tackman and D. Currey near Staple Island Bay, central Lake Winnipegosis, Manitoba (52.523°N, 100.023°W), at an elevation of 257.9 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, pre-Dawson level, of Lake Winnipegosis, and postglacial rebound.

The sample was collected from a 0.5-m excavation in the backshore of a prominent beach composed of pebbly medium sand and therefore dates the beach crest.

Beta-98796 Lake Winnipegosis XV

normalized age: 5820 ± 90
$\delta^{13}C$= +0.5‰
uncorrected age: 5400 ± 90

The freshwater shells (*Marstonia gelida*; identified by G.E. Tackman) were enclosed in beach crest pebbly medium sand. Sample '602-1.8' was collected by G.E. Tackman and D. Currey near Fox Lake, central Lake Winnipegosis, Manitoba (52.658°N, 100.093°W), at an elevation of 258.9 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, pre-Dawson level, of Lake Winnipegosis, and postglacial rebound.

The sample was collected from a 0.4-m excavation in the backshore of a prominent beach composed of pebbly medium sand and therefore the sample dates the beach crest.

Beta-98795 Lake Winnipegosis XVI

normalized age: 5810 ± 100
$\delta^{13}C$= +0.2‰
uncorrected age: 5400 ± 100

The freshwater shells (*Marstonia gelida*; identified by G.E. Tackman) were enclosed in beach crest pebbly medium sand. Sample '602-1.6' was collected by G.E. Tackman and D. Currey near Fox Lake, central Lake Winnipegosis, Manitoba (52.659°N, 100.093°W), at an elevation of 258.4 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, pre-Dawson level, of Lake Winnipegosis, and postglacial rebound.

The sample was collected in a pebbly medium sand from a rootball of an over-turned tree on the beach crest, therefore the sample dates the beach crest.

Wolf Lakes Series

A series of freshwater shell fragments samples from near Wolf Lakes, central Lake Winnipegosis, Manitoba (52.734°N, 100.432°W), at an elevation of 255.0 m, was collected by G.E. Tackman and D. Currey. These samples were submitted by G.E. Tackman to gain information on the beach crest, level 2, of Lake Winnipegosis, and postglacial rebound.

Beta-86331 (AMS) Lake Winnipegosis XVII

normalized age: 1150 ± 50
$\delta^{13}C$= -1.7‰
uncorrected age: 770 ± 50

The freshwater shell (unidentified gastropod) fragments of sample '519-1.3' from 0.46 m depth were enclosed in coarse beach gravel.

The calibrated age is 890 AD (865 AD - 975 AD).

Comment (G.E. Tackman): These shell fragments were high spiral gastropods. All were less than 2 cm in length with 5.5 whorls. The date provides a maximum age for level 2. Consult Beta-68072 (p. 58) in the section on 'Lake Manitoba' for additional comments.

Beta-86333 (AMS) Lake Winnipegosis XVIII

normalized age: 3160 ± 60
$\delta^{13}C$= -1.9‰
uncorrected age: 2780 ± 60

The freshwater shell (unidentified gastropod) fragments of sample '519-1.6' were a surface collection from ant hills on the beach crest.

The calibrated age is 1420 BC (1490 BC - 1390 BC).

Comment (G.E. Tackman): The shell fragments were high spiral, larger than *Marstonia gelida* and more rounded; 3 to 4 mm in length with 4.5 whorls. This sample dates the beach crest. Consult Beta-68072 (p. 58) in the section on 'Lake Manitoba' for additional comments.

GSC-4138 Lake Winnipegosis XIX

normalized age: 5280 ± 80
$\delta^{13}C$= +0.59‰
uncorrected age: 4870 ± 80

The freshwater gastropod shells (*Marstonia gelida*; identified by W.B. McKillop) were enclosed in beach sand underlying beach gravel, and overlying sand and fine gravel over grey clay. Sample 'PR-39' was collected by E. Nielsen on June 28, 1985, from about half way between the Bell and Shoal rivers (site 2) on the south shore of Dawson Bay, Lake Winnipegosis, Manitoba (52°44.17'N, 100°47.58'W), at an elevation of 259 m. This sample was submitted by E. Nielsen to gain information on lake level change, and rate of emergence of Lake Winnipegosis.

Comment (E. Nielsen): Both samples (GSC-4138 and -4139, below) are from abandoned beaches, 6 m above the present level of Dawson Bay, situated near the northern end of Lake Winnipegosis. The dates are comparable to a date of 5050 ± 100 BP (BGS-1126) on similar material and from about the same elevation at Denbeigh Point, 70 km to the northeast. The three dates indicate that during the last 5.0 ka the northern part of Lake Winnipegosis has undergone about 6 m of uplift with respect to the outlet situated at the southern end of the lake (Nielsen et al., 1987).

Beta-69184 Lake Winnipegosis XX

normalized age: 5210 ± 70
$\delta^{13}C$= +0.4‰
uncorrected age: 4790 ± 70

The freshwater shells (*Marstonia gelida*; identified by G.E. Tackman) were enclosed in a gastropod sand-bed within pebble-sized beach gravel. Sample '1-4.1' was collected by G.E. Tackman and D. Currey near Line Lake, northern Lake Winnipegosis, Manitoba (52.737°N, 100.795°W), at an elevation of 256.3 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, Dawson level, of Lake Winnipegosis, and postglacial rebound.

The calibrated age is 3630 BC (3680 BC - 3550 BC).

GSC-4139 Lake Winnipegosis XXI

normalized age: 5300 ± 70
$\delta^{13}C$= -0.51‰
uncorrected age: 4900 ± 70

The freshwater gastropod shells (*Marstonia gelida*; identified by W.B. McKillop) were enclosed in highly fossiliferous laminated beach sand underlying 1.5 m of shingled beach gravel. Sample 'PR-53' was collected by E. Nielsen on June 28, 1985, near the mouth of the Bell River (site 1) on the southwest shore of Dawson Bay, Lake Winnipegosis, Manitoba (52°44.67'N, 100°52.42'W), at an elevation of 259 m. This sample was submitted by E. Nielsen to gain information on lake level change, and rate of emergence of Lake Winnipegosis.

Beta-68082 Lake Winnipegosis XXII

normalized age: 880 ± 90
$\delta^{13}C$= -9.0‰
uncorrected age: 620 ± 90

The freshwater shells (*Sphaerium*; identified by G.E. Tackman) were enclosed in beach crest sediments. Sample '1-5.1' was collected from small exposures on the backshore of the beach by G.E. Tackman and D. Currey near Shoal River, northern Lake Winnipegosis, Manitoba (52.748°N, 100.690°W), at an elevation of 255.0 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level 2, of Lake Winnipegosis, and postglacial rebound.

The calibrated age is 1180 AD (1030 AD - 1270 AD).

BGS-1099 Lake Winnipegosis XXIII

normalized age: 710 ± 100
$\delta^{13}C$= -10.25‰
uncorrected age: 470 ± 100

The freshwater shells (*Lampsilis radiata siliquoidea*; identified by W.B. McKillop), sample 'EN-DB-1', were collected on September 4, 1913, from the west side of Dawson Bay, Lake Winnipegosis, Manitoba (52°50'N, 101°00'W), at an elevation of 253 m. This sample was submitted by E. Nielsen to gain information on the 'hardwater' error related to freshwater shells.

These pre-bomb modern shells are from an area of very hard water with abundant Paleozoic carbonate bedrock in the drainage basin, and as a result of 'hardwater' error exhibit an apparent age of 700 years BP.

Beta-68108 (AMS) Lake Winnipegosis XIV

normalized age: 3570 ± 60
$\delta^{13}C$= -0.6‰
uncorrected age: 3170 ± 60

The freshwater shells (*Stagnicola*; identified by G.E. Tackman) were a surface collection on the foreshore. Sample '4-2.17p' was collected by G.E. Tackman and D. Currey from Dawson Bay, northwestern

Lake Winnipegosis, Manitoba (52.888°N, 99.770°W), at an elevation of 256.8 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level 4, of Lake Winnipegosis, and postglacial rebound.

The calibrated age is 1900 BC (1965 BC - 1780 BC).

This sample dates the level 4 beach crest.

Beta-68112 (AMS) Lake Winnipegosis XXV

normalized age:	3910 ± 70
	$\delta^{13}C$= -7.0‰
uncorrected age:	3610 ± 70

The freshwater shells (*Sphaerium*; identified by G.E. Tackman) were enclosed in grey sandy mud overlain by 0.5 m of brown mud. Sample '1-1f' was collected by G.E. Tackman and D. Currey from the west bank of the Red Deer River, northwestern Lake Winnipegosis, Manitoba (52.893°N, 101.022°W), at an elevation of 252.6 m. This sample was submitted by G.E. Tackman to gain information on the shoreline of Lake Winnipegosis, and postglacial rebound.

The calibrated age is 2433 BC (2470 BC - 1935 BC).

The date relates to a minimum elevation for lake level.

Beta-68093 (AMS) Lake Winnipegosis XXVI

normalized age:	3980 ± 60
	$\delta^{13}C$= -1.9‰
uncorrected age:	3600 ± 60

The freshwater shells (*Stagnicola*; identified by G.E. Tackman) were enclosed in a bed of gastropod-rich sand within stratified sand and gravel. Sample '5-1.1' was collected by G.E. Tackman and D. Currey from Denbeigh Point, northeastern Lake Winnipegosis, Manitoba (52.897°N, 99.775°W), at an elevation of 258.6 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, below Dawson level, of Lake Winnipegosis, and postglacial rebound.

The calibrated age is 2465 BC (2565 BC - 2410 BC).

Comment (G.E. Tackman): This sample is below Dawson level, and is possibly level 4?

BGS-1126 Lake Winnipegosis XXVII

normalized age:	5450 ± 100
	$\delta^{13}C$= -0.43‰
uncorrected age:	5050 ± 100

The freshwater gastropod shells (*Marstonia gelida*; identified by W.B. McKillop) were enclosed in calcareous sand and mud. Sample 'DP-1' was collected by E. Nielsen on June 5, 1986, from Denbeigh Point (site 3) northeastern Lake Winnipegosis, Manitoba (52°54'N, 99°46'W). This sample was submitted by E. Nielsen to gain information on lake level change in Lake Winnipegosis.

Consult GSC-4138 (above, p. 99) for comments.

Beta-68091 Lake Winnipegosis XXVIII

normalized age:	6820 ± 70
	$\delta^{13}C$= -1.2‰
uncorrected age:	6430 ± 70

The freshwater shells (*Marstonia gelida*; identified by G.E. Tackman) were enclosed in buff-coloured beach sand. Sample '2-1.4f' was collected by G.E. Tackman and D. Currey from a road-drain cut near The Bluff, south of Dawson Bay on northwestern Lake Winnipegosis, west central Manitoba (52.914°N, 100.998°W), at an elevation of 257.5 m. This sample was submitted by G.E. Tackman to gain information on lake level change in Lake Winnipegosis, and postglacial rebound.

The calibrated age is 5665 BC (5710 BC - 5600 BC).

Comment (G.A. Tackman): A lack of context makes it difficult to interpret this date. Consult Beta-68072 (p. 58) in the section on 'Lake Manitoba' for additional comments.

Beta-69185 Lake Winnipegosis XXIX

normalized age:	5400 ± 80
	$\delta^{13}C$= -0.1‰
uncorrected age:	4990 ± 80

The freshwater shells (*Marstonia gelida*; identified by G.E. Tackman) were enclosed in gastropod-rich beach sand and gravel. Sample '6-2.1' was collected by G.E. Tackman and D. Currey near Denbeigh Point, northeastern Lake Winnipegosis, Manitoba (52.934°N, 99.752°W), at an elevation of 262.4 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, Dawson level, of Lake Winnipegosis, and postglacial rebound.

The calibrated age is 3800 BC (3920 BC - 3720 BC).

Beta-98799 (AMS) Lake Winnipegosis XXX

normalized age:	6150 ± 60
	$\delta^{13}C$= +1.0‰
uncorrected age:	5720 ± 60

The freshwater shells (*Marstonia gelida*; identified by G.E. Tackman) were enclosed in brownish-grey sand in an ant hill. Sample '603-1.17' (0.1 m below highest beach) was collected by G.E. Tackman and D. Currey near Denbeigh Point, northeastern Lake Winnipegosis, Manitoba (52.942°N, 99.723°W), at an elevation of 264.2 m. This sample was submitted by G.E. Tackman to gain information on the shoreline, Denbeigh level, of Lake Winnipegosis, and postglacial rebound.

Beta-68090 Lake Winnipegosis XXXI

normalized age:	6880 ± 180
	δ13C= -0.5‰
uncorrected age:	6190 ± 60

The freshwater shells (*Marstonia gelida*; identified by G.E. Tackman) were from a small excavation in the beach-crest surface in beach-crest sediments. Sample '6-1.5' was collected by

G.E. Tackman and D. Currey near Denbeigh Point, northeastern Lake Winnipegosis, Manitoba (52.943°N, 99.724°W), at an elevation of 264.0 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, Denbeigh level, of Lake Winnipegosis, and postglacial rebound.

The calibrated age is 5485 BC (5580 BC - 5440 BC).

Beta-98797 Lake Winnipegosis XXXII

normalized age:	6880 ± 180
	$\delta^{13}C$= +0.1‰
uncorrected age:	6470 ± 170

The freshwater shells (*Marstonia gelida*; identified by G.E. Tackman) were enclosed in tan well sorted fine-to-medium sand overlying Lake Agassiz shingle beach gravel. Sample '603-2.1' was collected by G.E. Tackman and D. Currey near Denbeigh Point, northeastern Lake Winnipegosis, Manitoba (52.944°N, 99.726°W), at an elevation of 261.1 m. This sample was submitted by G.E. Tackman to gain information on the shoreline, Denbeigh level, of Lake Winnipegosis, and postglacial rebound.

Beta-68092 (AMS) Lake Winnipegosis XXXIII

normalized age:	5350 ± 60
	$\delta^{13}C$= +0.1‰
uncorrected age:	4940 ± 60

The freshwater shells (*Marstonia gelida*; identified by G.E. Tackman) were a surface collection on sand where three beaches of similar elevation converge. Sample '522-1.4' was collected by G.E. Tackman and D. Currey from Grassy Point, northeastern Lake Winnipegosis, Manitoba (52.972°N, 99.896°W), at an elevation of 263.1 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, Dawson level, of Lake Winnipegosis, and postglacial rebound.

The calibrated age is 4155 BC (4315 BC - 4085 BC).

Beta-86335 Lake Winnipegosis XXXIV

normalized age:	8210 ± 90
	$\delta^{13}C$= -0.8‰
uncorrected age:	7810 ± 90

The freshwater shells (*Marstonia gelida*; identified by G.E. Tackman) were enclosed in 1.5 m-humic sand and gravel abruptly overlying buff-coloured clay with red horizons. Sample '520-1.1' (about 0.5 m (1.5 ft) below clay unit top) was collected by G.E. Tackman and D. Currey from Dawson Bay village beach, northwestern Lake Winnipegosis, Manitoba (52.974°N, 100.988°W), at an elevation of 259.8 m. This sample was submitted by G.E. Tackman to gain information on the beach crest of Lake Winnipegosis, and postglacial rebound.

The calibrated age is 7245 BC (7325 BC - 7040 BC).

Beta-77525 (AMS) Lake Winnipegosis XXXV

normalized age:	4760 ± 60
	$\delta^{13}C$= -4.4‰
uncorrected age:	4420 ± 60

The freshwater shell fragments (unidentified gastropod) were enclosed in 1.1 m of sand and gravel over 0.1 m clayey sand, over grey Agassiz clay with discontinuous oxidized (red) zones. Sample '404-3f' (fossil site) was collected by G.E. Tackman and D. Currey from Burrell Bay, northwestern Lake Winnipegosis, Manitoba (52.975°N, 101.010°W), at an elevation of 256.5 m. This sample was submitted by G.E. Tackman to gain information on the shoreline, late Dawson level, of Lake Winnipegosis, and postglacial rebound.

The calibrated age is 3573 BC (3640 BC - 3390 BC).

Comment (G.E. Tackman): These shell fragments were high spiral gastropods and all were less than 2 cm in length with 5.5 whorls. The date provides an age on the minimum elevation for the lake level.

Beta-98807 Lake Winnipegosis XXXVI

normalized age:	4690 ± 80
	$\delta^{13}C$= +1.0‰
uncorrected age:	4260 ± 80

The freshwater shells (*Marstonia gelida*; identified by G.E. Tackman) were enclosed in beach sand and gravel. Sample '1996-DBC' was collected by N. Leask from Dawson Bay village cemetery, northwestern Lake Winnipegosis, Manitoba (52.976°N, 100.984°W), at an elevation of 257.9 m. This sample was submitted by G.E. Tackman to gain information on the shoreline, late Dawson level, of Lake Winnipegosis, and postglacial rebound.

Beta-68078 Lake Winnipegosis XXXVII

normalized age:	5190 ± 70
	$\delta^{13}C$= +0.2‰
uncorrected age:	4780 ± 70

The freshwater shells (*Marstonia gelida*; identified by G.E. Tackman) were enclosed in beach gravel. Sample '2-3f' (fossil site) was collected by G.E. Tackman and D. Currey from a gravel pit at Dawson Bay, northwestern Lake Winnipegosis, Manitoba (52.982°N, 100.977°W), at an elevation of 256.6 m. This sample was submitted by G.E. Tackman to gain information on the shoreline, Dawson level, of Lake Winnipegosis, and postglacial rebound.

The calibrated age is 3980 BC (4080 BC - 3955 BC).

The sample provides a minimum age for the Dawson level, and an age for the minimum elevation for the lake level.

Beta-68074 (AMS) Lake Winnipegosis XXXVIII

normalized age:	440 ± 70
	$\delta^{13}C$= -6.4‰
uncorrected age:	130 ± 70

The freshwater shells (*Lampsilis radiata*; identified by G.E. Tackman) were enclosed in beach-crest sediments. Sample 3-1.3p' (0-30 cm below beach crest) was collected by G.E. Tackman and D. Currey from Oscar Point, northern Lake Winnipegosis, Manitoba (53.110°N, 100.409°W), at an elevation of 254.8 m. This sample was submitted by G.E. Tackman to gain information on the beach crest, level 1, of Lake Winnipegosis, and postglacial rebound.

The calibrated age is 1445 AD (1425 AD - 1485 AD).

This sample dates the beach crest.

Beta-69186 Lake Winnipegosis XXXIX

normalized age:	4760 ± 90
	$\delta^{13}C$= -0.1‰
uncorrected age:	4350 ± 90

The small freshwater shell (*Marstonia gelida*; identified by G.E. Tackman) was enclosed in the top of 0.8 m of fossiliferous deltaic sand, over 0.6 m sand with interbedded dark grey clay. Sample '31-1.1f' was collected by G.E. Tackman and D. Currey from Overflowing River, northern Lake Winnipegosis, Manitoba (53.139°N, 101.089°W), at an elevation of 254.4 m. This sample was submitted by G.E. Tackman to gain information on the shoreline, late Dawson level, of Lake Winnipegosis, and postglacial rebound.

The calibrated age is 3030 BC (3180 BC - 2900 BC).

The sample provides a date on the minimum elevation for the lake level.

Radiocarbon Dates on other lakes

Beta-77526 (AMS) Kawinaw Lake

normalized age:	4480 ± 50
	$\delta^{13}C$ = -1.2‰
uncorrected age:	4090 ± 50

The freshwater shells (*Amnicola limosa*; identified by G.E. Tackman) were a surface collection from ant hills in a beach. Sample '406-1.12' was collected by G.E. Tackman and D. Currey near Denbeigh Point, northeastern Lake Winnipegosis, Manitoba (52.898°N, 99.501°W), at an elevation of 259.7 m. This sample was submitted by G.E. Tackman to gain information on the beach crest of Kawinaw Lake, and postglacial rebound.

The calibrated age is 3201 BC (3340 BC - 3045 BC).

The sample dates the beach crest. See Beta-68072 (p. 58) in the section on 'Lake Manitoba' for additional comments.

Whitewater Lake Series

A series of freshwater shell samples from near Whitewater Lake, about 20 km west of Boissevain, southwestern Manitoba (49.222°N, 100.265°W), at an elevation of about 1635 m, was collected by G.E. Tackman and D. Currey. These samples were submitted by G.E. Tackman to gain information on the beach crest of Whitewater Lake, and postglacial rebound.

Beta-98805 (AMS) Whitewater Lake I

normalized age:	580 ± 50
	$\delta^{13}C$= -8.6‰
uncorrected age:	320 ± 50

The freshwater shells (*Limnaea stagnalis*; identified by G.E. Tackman) of sample '628-1DON' were enclosed in pebbly humic sand from a badger hole.

Beta-98806 (AMS) Whitewater Lake II

normalized age:	100 ± 40
	$\delta^{13}C$= -9.6‰
uncorrected age:	modern

The freshwater shells (*Limnaea stagnalis*; identified by G.E. Tackman) of sample '629-2' were enclosed in pebbly humic sand from a badger hole.

Please refer to Beta-68072 (p. 58) in the section on 'Lake Manitoba' for additional comments.

RADIOCARBON DATES RELATED TO SEA LEVEL CHANGE[3] (Fig. 9)

BGS-1042 Kaskattama Highland

uncorrected age: 7400 ± 100

The marine shells (*Hiatella arctica*; identified by E. Nielsen) were a surface collection in a creek bed. Sample 'EN No. 1' was collected by E. Nielsen and L.A. Dredge on June 5, 1985, on the south side of the Kaskattama Highland, Peckinow River area, northeastern Manitoba (55°50'N, 91°42'W), at an elevation of 130 m. This sample was submitted by E. Nielsen to gain information on sea level change, and the maximum level for the Tyrrell Sea.

Comment (E. Nielsen): The shells were from close to the marine limit on the south side of the Kaskattama Highland. The shells were not *in situ*, and the elevation could not be accurately measured.

GSC-3926 Stupart River

normalized age: 7510 ± 90
corrected age: 7110 ± 90
$\delta^{13}C = +1.00‰$
uncorrected age: 7090 ± 90

The marine shells (*Mya truncata*; identified by L.A. Dredge) were enclosed in sand. Sample 'DU-84-52' (GSC Locality No. O-106694) was collected by L.A. Dredge and E. Nielsen on June 9, 1984, from the Stupart River at the mouth of the Fox River, Manitoba (55°59'N, 93°23'W), at an elevation of 90 m. This sample was submitted by L.A. Dredge to gain information on sea level change, and a minimum age for the Tyrrell Sea.

Comment (L.A. Dredge): The shells provide a minimum age for the unit in the section (described in Dredge and Nielsen, 1985) and date the Tyrrell Sea deposits in this area.

Comment (W. Blake, Jr.): The sample submitted for dating consisted of 11 left valves and 12 right valves, nearly all whole. The largest valve was 4.8 cm long and >3 cm high. Most of these aragonitic shells retained some periostracum and some internal lustre; none were pitted or encrusted.

GSC-878 Hayes River

uncorrected age: 7570 ± 140

The marine shells (*Hiatella arctica*; identified by W. Blake, Jr.) were enclosed in silty clay. Sample 'MR-181a/67' was collected by B.C. McDonald on August 7, 1967, from the Hayes River, 3.2 km above the mouth of the Fox River, Hudson Bay Lowland, Manitoba (56°02'20"N, 93°17'W), at an elevation of 114 m. This sample was submitted by B.G. Craig to gain information on deglaciation, and sea level change.

Comment (B.G. Craig): The dates of this series help determine the time of deglaciation and marine incursion.

See GSC-896 (below) for additional comments.

GSC-1742 Gods River I

uncorrected age: 490 ± 140

The wood (*Picea*; identified by R.J. Mott (unpublished GSC Wood Report No. 72-23)) was enclosed in a gravelly zone overlying the upper clayey till and underlying brown clay beneath recent peats. Sample 'KJ-58-72' (4.5 m depth) was collected by J.A. Netterville on June 23, 1972, along Gods River in the Hudson Bay Lowlands, northeastern Manitoba (56°09'N, 92°31'W), at an elevation of 43 m. This sample was submitted by R.W. Klassen to gain information on sea level change.

Comments (R.W. Klassen): This sample was thought to predate the brown clay considered to be associated with the last marine inundation of this area some 7000 years ago. The age of the wood indicates that the sample was not in place when the last marine inundation of the area occurred some 7000 years ago.

GSC-1955 Gods River II

normalized age: 6990 ± 100
corrected age: 6590 ± 100
$\delta^{13}C = -1.32‰$
uncorrected age: 6610 ± 100

The marine shells (*Mytilus edulis*; identified by W. Blake, Jr.) were enclosed in surficial marine sand. Sample 'KJ-84(a and b)-73' (GSC Locality No. O-107932) was collected by J.A. Netterville on June 26, 1973, from Gods River, about 19 km upstream of its junction with Hayes River in the Hudson Bay Lowlands, northeastern Manitoba (56°15'N, 92°45'W), at an elevation of about 75 m. This sample was submitted by R.W. Klassen to gain information on sea level change.

Comment (R.W. Klassen): The date is compatible with other age determinations of Holocene marine shells from the southwest side of Hudson Bay.

GSC-896 'Old Beach Creek'

uncorrected age: 8530 ± 220

The marine shell fragments (*Hiatella arctica*; identified by B.G. Craig) were enclosed in beach sand. Sample 'CD-116/67' was collected by B.G. Craig and B.C. McDonald on August 11, 1967, from 'Old Beach Creek', 85 km south of mouth of Kaskattama River, Hudson Bay Lowlands, Manitoba (56°18'N, 90°24'W), at an elevation of 125 m. This sample was submitted by B.G. Craig to gain information on deglaciation, and sea level change.

Comment (B.G. Craig): The date is not compatible with the rest of the series. The sample has been both redeposited and contaminated.

General comment on series (B.G. Craig): This series comprises dates on several shell collections near marine limit across Hudson Bay Lowlands to determine time of deglaciation and marine invasion. Along with I(GSC)-14 (7875 ± 200; in Terasmae and Hughes, 1960),

[3] Please consult the 'Introduction' on page 1 for the format of data presentation on marine shell dates.

I(GSC)-8 (6975 ± 250; in Lee, 1959) and GSC-289 (6830 ± 170; Craig, 1965), present series indicates that samples from southwest of James Bay (about 7900 to 7400 BP) are clearly older than those from west and northwest of Hudson Bay (about 6900 to 6600 BP; Craig, 1969). The age of 8530 ± 220 on GSC-896, above, is not compatible with rest of series. As shells are found throughout area in deposits that predate Tyrrell Sea deposits, it is assumed that this collection is both redeposited and contaminated (cf. also GX-1063, 8010 ± 95, on shells 80 km southwest of Churchill; Wagner, 1967).

Nelson River Series

A series of marine shell samples from east of Gillam, on the lower Nelson River, northeastern Manitoba (56°20'N, 94°42'W; coordinates approximate) was collected by E. Nielsen in June, 1980. These samples were submitted by E. Nielsen to gain information on sea level change in the Tyrrell Sea.

BGS-815 Nelson River I

uncorrected age: 7050 ± 150

The marine shells, sample 'EN-408' (*Hiatella arctica*; identified by E. Nielsen), were enclosed in sand.

BGS-814 Nelson River II

uncorrected age: 7300 ± 200

The marine shells, sample 'EN-429' (*Hiatella arctica*; identified by E. Nielsen), were enclosed in sand.

BGS-813 Nelson River III

uncorrected age: 8200 ± 300

The marine shells, sample 'EN 508 (b)' (*Hiatella arctica*; identified by E. Nielsen) were enclosed in sand.

Comment (E. Nielsen): The 'Gillam' samples were dated to determine the earliest inundation by the Tyrrell Sea in northern Manitoba. BGS-812 (below) and -813 suggest this may have been as early as 8000 BP.

BGS-713 Gillam

uncorrected age: 6750 ± 150

The marine shells (*Hiatella arctica*; identified by E. Nielsen) were enclosed in sand. Sample 'EN-427' was collected by E. Nielsen on June 15, 1980, from a river cutbank near Leslie Creek and Gillam on the lower Nelson River, Manitoba (56°23'10"N, 94°13'10"W), at an elevation of 90 m. This sample was submitted by E. Nielsen to gain information on sea level change of the Tyrrell Sea.

Long Spruce Dam Series

A series of marine shell samples from the left bank of the Nelson River, 1.4 km below the Long Spruce Dam, Manitoba (56°24.9'N, 94°20.5'W; GSC Locality No. O-107970), at elevations of 100 m and 30 m, was collected by E. Nielsen in May, 1982, and by L.A. Dredge and E. Nielsen on June 18, 1984. These samples were submitted by L.A. Dredge to gain information on sea level change of the Tyrrell Sea.

GSC-3916 Long Spruce Dam I

normalized age: 8160 ± 80
corrected age: 7760 ± 80
$\delta^{13}C = -1.50‰$
uncorrected age: 7780 ± 80

The marine shells, sample 'DU-84-136' (*Macoma calcarea*; identified by W. Blake, Jr.), were enclosed in fine sand.

Comment (L.A. Dredge): GSC-3916 agrees with a Brock University date of 8000 ± 200 BP (BGS-812) from the same site.

Comment (W. Blake, Jr.): The sample included a number of well preserved aragonitic whole valves (largest: 3.2 by 2.2 cm) with some periostracum on nearly all valves. Some unidentified grey spots were present. Most valves retained reasonably good internal lustre, and none of the shells was pitted, encrusted, or chalky.

BGS-812 Long Spruce Dam II

uncorrected age: 8000 ± 200

The marine shells, sample 'GAC-9' (cf. DU-84-136) (*Macoma calcarea*; identified by E. Nielsen), were enclosed in calcareous silt.

See BGS-813 (above) for additional comments.

BGS-712 Leslie Creek

uncorrected age: 6990 ± 130

The marine shells (*Hiatella arctica*; identified by E. Nielsen) were enclosed in sand. Sample 'EN-419 (b)' was collected by E. Nielsen on June 10, 1980, from a river cutbank near Leslie Creek on the lower Nelson River, Manitoba (56°25'45"N, 94°12'12"W), at an elevation of 90 m. This sample was submitted by E. Nielsen to gain information on sea level change in the Tyrrell Sea.

GSC-2294 Moondance Creek

normalized age: 7430 ± 170
corrected age: 7030 ± 170
$\delta^{13}C = -0.07‰$
The uncorrected age: 7030 ± 170

The marine shells, whole valves and fragments of *Hiatella arctica* (identified by W. Blake, Jr.), were enclosed in clay. Sample 'KJ-2-71' (GSC Locality No. O-107930) was collected by R.W. Klassen on August 21, 1971, from a river cutbank near Moondance Creek on the Nelson River, Manitoba (56°31.2'N, 94°04.8'W), at an elevation of 90 m. This sample was submitted by R.W. Klassen to gain information on sea level change.

Comment (R.W. Klassen): The sample is slightly younger than dated shells from the same unit along Hayes River (7.6 ka BP, GSC-878) at an elevation of 114 m, and it overlaps in age with a dated shell sample from 140 m along Churchill River (7.3 ka BP, GSC-92; both in Craig, 1969). Marine inundation of the Lowland along Nelson River likely occurred about 7500 years ago.

Comment (W. Blake, Jr.): *Mya truncata* also occurred in the sample, but only *Hiatella arctica* was used for dating. The latter

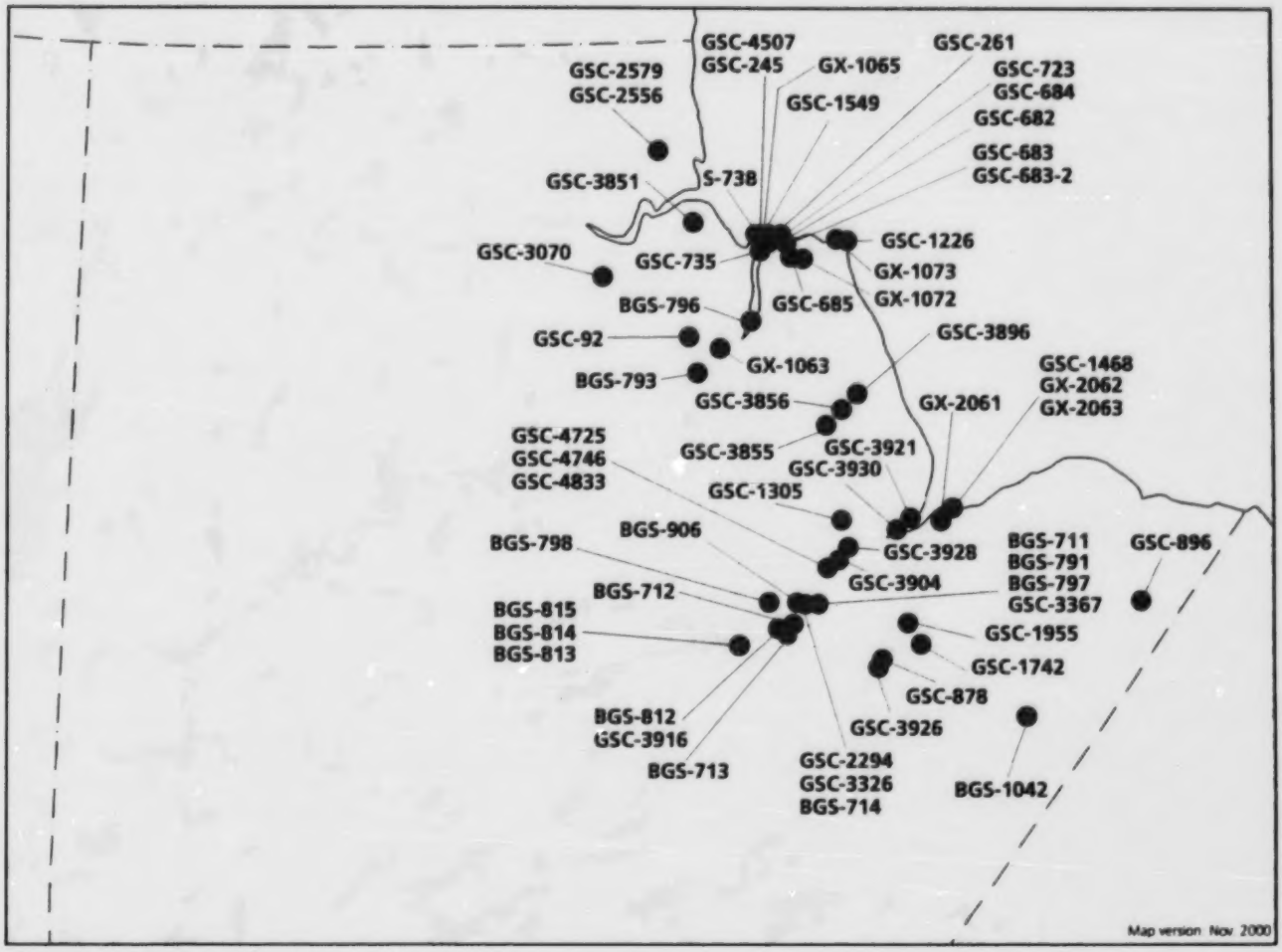

Figure 9. Radiocarbon dates related to sea level change.

species comprised whole shells (up to 2.5 cm long) and fragments. All pieces were chalky on the exterior, some retained internal lustre, and the shells were aragonitic.

Sundance Creek Series

A series of marine shell samples from a river cutbank near Sundance Creek, 2.7 km downstream of the Limestone Dam on the north side of the lower Nelson River, Manitoba (56°31.8'N, 94°05.1'W; GSC Locality No. O-106699), at elevations of 90 m and 76 m, was collected by E. Nielsen on June 26, 1980 and by E. Nielsen and L.A. Dredge on July 21, 1981. These samples were submitted by E. Nielsen to gain information on sea level change, and to provide a crosscheck date.

BGS-714 Sundance Creek I

uncorrected age: 6900 ± 150

The marine shells, sample 'EN-442 (c)' (*Hiatella arctica*; identified by E. Nielsen), were enclosed in sand. These shell samples were taken 3 to 5 m from the surface, between 94°00'W and 94°15'W, in an area where the underlying tills and bedrock are highly calcareous.

GSC-3326 Sundance Creek II

normalized age:	7580 ± 70
corrected age:	7180 ± 70
	$\delta^{13}C = +1.50‰$
uncorrected age:	7150 ± 70

The marine shells, sample 'E.N.-442' (whole valves of *Hiatella arctica*; identified by L.A. Dredge), were enclosed in sand.

Comment (L.A. Dredge): The sample was dated as an independent check on a Brock University date from this site which was reported to be 2000 years older. GSC-3326 corroborates a date of 7030 ± 170 years (GSC-2294; Lowdon and Blake, 1981, p. 7) from a site 2 km upstream (cf. Nielsen and Dredge, 1982). The Brock date has since been corrected.

Comment (W. Blake, Jr.): The Brock Laboratory discovered an error in their age calculation (because of a change in the modern standard); their new determination is 6900 ± 150 (BGS-714), a value which is in good agreement with GSC-3326 (Blake, 1983). These well preserved aragonitic pelecypod shells had no pitting or encrustations, their external ornamentation was intact (although no periostracum was preserved), and they were characterized by good internal lustre. All of the somewhat fragile shells making up this collection were whole; they varied in size from 1.3 x 0.6 cm to 2.7 x 1.3 cm, and most were >2 cm in length. The sample used for dating comprised 83 left valves and 83 right (not necessarily all pairs).

BGS-798 Sundance Creek III

uncorrected age: 6900 ± 100

The marine shells, sample 'EN-442 (b)' (*Hiatella arctica*; identified by E. Nielsen) were collected in gravelly sand from a channel cut into till. The current directions were easterly and the shells were associated with a diverse marine fauna.

BGS-906 Limestone River

uncorrected age: 7120 ± 120

The marine shells (*Macoma calcarea*; identified by E. Nielsen) were enclosed in calcareous silty sand. The sample 'EN-445' was collected by E. Nielsen on June 6, 1983, from the Limestone River, 8 km (5 mi) upstream from junction with Nelson River, Manitoba (56°32'N, 94°14'W), at an elevation of about 76 m. This sample was submitted by E. Nielsen to gain information on sea level change.

Limestone Dam Series

A series of marine shell samples from 6.7 km downstream of the Limestone Dam on the south side of the lower Nelson River, Manitoba between 94°00' and 94°15', at elevations of 64 to 68 m, was collected by E. Nielsen on June 2, 1980 and by E. Nielsen and L.A. Dredge on July 22, 1981. These samples were submitted by E. Nielsen to gain information on sea level change in the Tyrrell Sea and to provide a crosscheck date.

BGS-711 Limestone Dam I

uncorrected age: 6280 ± 180

The marine shells, sample 'EN-411 (c)' (*Hiatella arctica*; identified by E. Nielsen), were enclosed in sandy gravel underlying 4 m of marine clay. This series of shells were taken 3 to 5 m from the surface in an area where the underlying tills and bedrock are highly calcareous.

BGS-797 Limestone Dam II

uncorrected age: 6560 ± 140

The marine shells, sample 'EN-411 (a)' (*Macoma baltica*; identified by E. Nielsen), were enclosed in 1 m of sand overlying 4 m of grey marine clay which overlies a *Hiatella*-rich sand and gravel.

BGS-791 Limestone Dam III

uncorrected age: 6760 ± 100

The marine shells, sample 'EN-411 (c)' (*Hiatella arctica*; identified by L.A. Dredge) were enclosed in sand. The underlying tills and bedrock are highly calcareous.

GSC-3367 Limestone Dam IV

normalized age: 7160 ± 80
corrected age: 6760 ± 80
$\delta^{13}C = +0.30‰$
uncorrected age: 6750 ± 80

The marine shells, sample 'E.N.-411 (c)' (whole valves of *Hiatella arctica*; identified by L.A. Dredge), were enclosed in glaciofluvial gravel. This sample is a re-collection of an earlier sample 'E.N. 411 (c)' (BGS-711).

Comment (L.A. Dredge): The sample was dated as an independent check of a Brock University date from this site which was first reported to be nearly 1500 years older.

Comment (W. Blake, Jr.): This large sample of well preserved shells was washed in distilled water to remove adhering sand, air dried, and then 533 valves were broken into half, so that a sample as nearly identical as possible to that processed at the Geological Survey of Canada (47.9g) could be sent to Brock University (50.9 g). An identical result was obtained at Brock (BGS-791, 6760 ± 100 years; Blake, 1983).

The shells were characterized by good external ornamentation (but no periostracum), and good internal lustre. There were no encrustations or other contaminants. The largest valve was 2.5 x 1.2 cm; the smallest, representative of a number of fragile, juvenile shells, was less than 1 cm in length.

GSC-4746 Conawapa Dam site I

normalized age: 7680 ± 80
corrected age: 7280 ± 80
$\delta^{13}C = +3.02‰$
uncorrected age: 7240 ± 80

The marine shells, whole valves of *Hiatella arctica* (identified by E. Nielsen), were enclosed in cross-bedded sand underlying fine texture nearshore, lagoonal Tyrrell Sea sediments. Sample 'CON-88-6' was collected by E. Nielsen on August 20, 1988, from the Conawapa Dam site on the Nelson River, northeastern Manitoba (56°41'25"N, 93°46'40"W), at an elevation of 45 m. This sample was submitted by E. Nielsen to gain information on the Tyrrell Sea, and the paleoenvironmental conditions.

Comment (E. Nielsen): The relatively large, mostly single, valves were collected from the bedding plane surfaces of cross-bedded sand underlying fine texture nearshore, lagoonal Tyrrell Sea sediments exposed at the top of the section and dated at 6810 ± 80 BP (GSC-4725). The shells were reworked and deposited possibly in offshore tidal or estuarine channels at an unknown water depth. The current directions in the channels were toward the east and northeast parallel to the present Nelson River.

GSC-4833 Conawapa Dam site II

normalized age:	7110 ± 110
corrected age:	6710 ± 110
	$\delta^{13}C$= +3.20‰
uncorrected age:	6660 ± 110

The marine shells, *in situ* whole valves of *Hiatella arctica* (identified by E. Nielsen) were enclosed in a thick silt unit overlying about 2 m of fossiliferous sand and gravel. Sample 'CON-88-9' was collected by E. Nielsen on August 21, 1988, from the Conawapa Dam site on the Nelson River, northeastern Manitoba (56°41'25"N, 93°48'30"W), at an elevation of 64 m. This sample was submitted by E. Nielsen to gain information on sea level change, i.e. emergence.

Comment (E. Nielsen): The shells were collected from the base of a 6 m-thick silt unit overlying about 2 m of fossiliferous sand and gravel. The shells were in growth position. The presence of *Mytilus*, gastropods and brachiopods, as well as the fine texture of the enclosing sediment, suggests deposition in a near tidal, possibly lagoonal environment. The sample dates the regression of the Tyrrell Sea from the area.

GSC-4725 Conawapa Dam site III

normalized age:	7210 ± 80
corrected age:	6810 ± 80
	$\delta^{13}C$= +1.92‰
uncorrected age:	6780 ± 80

The basal marine shells, paired valves of *Hiatella arctica* (identified by E. Nielsen) in growth position, were enclosed in the base of a 6 m-thick silty clay unit. Sample 'CON-88-5' was collected by E. Nielsen on August 20, 1988, from the Conawapa Dam site on the Nelson River, northeastern Manitoba (56°41'30"N, 93°46'40"W), at an elevation of 62 m. This sample was submitted by E. Nielsen to gain information on sea level change, and paleoenvironmental conditions.

Comment (E. Nielsen): Small, paired valves, in growth position, were collected from the base of a 6 m-thick silty clay unit deposited in the Tyrrell Sea. The presence of *Mytilus* shells and the fine texture indicates deposition in a nearshore, possibly lagoonal environment.

GSC-3904 Angling River I

normalized age:	7650 ± 80
corrected age:	7250 ± 80
	$\delta^{13}C$= +0.90‰
uncorrected age:	7230 ± 80

The marine shells (*Hiatella arctica*; identified by W. Blake, Jr.) were enclosed in medium sand and gravel. Sample 'DU-84-89' (GSC Locality No. O-106697) was collected by L.A. Dredge and E. Nielsen on June 12, 1984, from the Nelson River at the mouth of the Angling River, northern Manitoba (56°45.0'N, 93°36.5'W), at an elevation of 15 m. This sample was submitted by L.A. Dredge to gain information on sea level change.

Comment (W. Blake, Jr.): Only the better quality aragonitic *Hiatella arctica* shells were selected after the sample was washed in distilled water and air-dried. These shells were somewhat chalky, but a few bits of periostracum remained. Most shells retained their internal lustre, but a few grey spots (of unknown origin) were present. Some shells were characterized by worn exterior surfaces, but some retained good ornamentation.

GSC-3928 Angling River II

normalized age:	7300 ± 130
corrected age:	6900 ± 130
	$\delta^{13}C$= -0.40‰
uncorrected age:	6910 ± 130

The marine shells (*Clinocardium ciliatum*; identified by W. Blake, Jr.) were enclosed in sand and gravel. Sample 'DU-84-94' (GSC Locality No. O-106698) was collected by L.A. Dredge and E. Nielsen on June 12, 1984, from an island in the Nelson River 13 km downstream from the Angling River, Manitoba (56°50.4'N, 93°30.0'W), at an elevation of 15 m. This sample was submitted by L.A. Dredge to gain information on sea level change.

Comment (W. Blake, Jr.): Many of the shells, especially *Mya truncata, Hiatella arctica*, and *Macoma calcarea* exhibited worn exterior surfaces, little lustre, no periostracum, and considerable chalkiness, all features that suggested transport. Thus *Clinocardium ciliatum* was used for dating, as because of its fragile nature it breaks easily during transport. The aragonitic shells of this species retained good internal lustre and good external ornamentation, suggesting less transport. The largest intact valve measured 3.6 by 3.5 cm.

GX-2061 Gander Creek

uncorrected age:	2065 ± 125

The driftwood was enclosed in sand and gravel overlain by alluvial silt, sand, clay, and underlain by marine clay. The sample was collected by S.J. Simpson in 1969, from the north side of Hayes River at Gander Creek, 8 km southwest (upriver) from York Factory, Manitoba (56°57'40"N, 92°23'10"W), at an elevation of 10 m. This sample was submitted by S.J. Simpson to gain information on sea level change.

Comments on this sample are presented after GX-2062 below.

GSC-3930 Nelson River Estuary

normalized age:	7770 ± 90
corrected age:	7370 ± 90
	$\delta^{13}C$= +1.80‰
uncorrected age:	7340 ± 90

The marine shells (*Mya truncata*; identified by W. Blake, Jr.) were enclosed in silty sand. Sample 'DU-84-69' (GSC Locality No. O-106695) was collected by L.A. Dredge and E. Nielsen on June 11, 1984, from the north shore of the Nelson River Estuary, 13 km upstream of Port Nelson, Manitoba (56°58.1'N, 92°47.0'W), at an elevation of 30 m. This sample was submitted by L.A. Dredge to gain information on sea level change, and deglaciation.

Comment (L.A. Dredge): The shells provide a minimum age for the tills and glaciolacustrine deposits, and date the marine (Tyrrell Sea) unit.

Comment (W. Blake, Jr.): Only *Mya truncata* was used for dating, although *Macoma calcarea* and *Hiatella arctica* were represented in the collection. Thirty left valves and 16 right valves were used; all retained some periostracum and some internal lustre. Some of the aragonitic valves were iron-stained, but none were pitted or encrusted. The largest whole valve measured 3.5 by 2.3 cm. All shells were less than 1 mm-thick except at the posterior end and in the hinge area.

GSC-1305 York Factory

normalized age: 1930 ± 130
$\delta^{13}C$= -25.3‰
uncorrected age: 1930 ± 130

The driftwood (*Picea*; identified by R.J. Mott (unpublished GSC Wood Report No. 70-04)) was enclosed in sand and gravel over marine clay and sand and under alluvial sand and clay below a surface peat. Sample 'Site (2) No. 1' was collected by S.J. Simpson on July 28, 1969, from the left bank of the Hayes River, 2.4 km southwest of York Factory, Manitoba (56°59'N, 93°39'W), at an elevation of about 5.5 m. This sample was submitted by S.J. Simpson to gain information on sea level change, and the rate of emergence.

GSC-3921 Port Nelson

normalized age: 7430 ± 100
corrected age: 7030 ± 100
$\delta^{13}C$= +1.80‰
uncorrected age: 7000 ± 100

The marine shells (*Hiatella arctica*; identified by L.A. Dredge) were enclosed in silty clay rhythmites. Sample 'DU-84-80' (GSC Locality No. O-107972) was collected by L.A. Dredge and E. Nielsen on June 10, 1984, from the north shore of the Nelson River estuary, 4.5 km upstream from Port Nelson, Manitoba (57°01.6'N, 92°38.0'W), at an elevation of 16 m. This sample was submitted by L.A. Dredge to gain information on sea level change.

Comment (L.A. Dredge): The sample dates the uppermost unit of this reference section (Dredge and Nielsen, 1985).

Comment (W. Blake, Jr.): Only *Hiatella arctica* was used for dating, although *Macoma calcarea* and *Clinocardium ciliatum* (identified by W. Blake, Jr.) were also present. The maximum size of the aragonitic *Hiatella arctica* valves was 3.4 by 1.6 cm. All valves exhibited good external ornamentation and good internal lustre. The shells were not pitted or encrusted, but some had grey spots. No periostracum was preserved.

GX-2062 Raven Creek

uncorrected age: 1055 ± 125

The driftwood was enclosed in gravel overlain by alluvial silt, sand, and clay, and underlain by marine clay to sand. The sample was collected by S.J. Simpson in 1969, from the north side of Hayes River at Raven Creek, 3.8 km northeast (downriver) from York Factory, Manitoba (57°01'40"N, 92°16'20"W), at an elevation of 4 m. This sample was submitted by S.J. Simpson to gain information on sea level change, and the rate of emergence.

Comment (S.J. Simpson): Age reflects time of regression of Hudson Bay shoreline due to uplift. Oldest dates from same unit in this series (GSC-1305, -1468, GX-2061, -2062, -2063) are at a higher elevation and are farther inland.

GX-2063 Palsa Creek

uncorrected age: 1255 ± 105

The driftwood was enclosed in sand and gravel overlain by alluvial silt, sand, and clay, and underlain by marine clay. The sample was collected by S.J. Simpson in 1969, on north side of Hayes River at Palsa Creek, 5.6 km northeast (downriver) from York Factory, Manitoba (57°02'50"N, 92°15'20"W), at an elevation of 2.3 m. This sample was submitted by S.J. Simpson to gain information on sea level change, and the rate of emergence.

Comment (S.J. Simpson): This date may be several hundred years too old, possibly because of redeposition from an older site.

GSC-1468 Marsh Point

normalized age: 660 ± 190
$\delta^{13}C$= -26.5‰
uncorrected age: 680 ± 190

The driftwood sample, 'Site (13) No. 1', was collected by S.J. Simpson in July, 1970, from the northwest bank of Hayes River estuary, about 3 km southwest of Marsh Point, York Factory area, Manitoba (57°03'N, 92°14'W), at an elevation of about 2.4 m. This sample was submitted by S.J. Simpson to gain information on sea level change, and the rate of emergence.

General comments on series (W. Blake, Jr.): These two age determinations (GSC-1305 and -1468) are part of a series used by Simpson (1972) to construct a postglacial uplift model for the lower Hayes River area.

GSC-3855 Owl River I

normalized age: 7280 ± 130
corrected age: 6880 ± 130
$\delta^{13}C$= +1.60‰
uncorrected age: 6860 ± 130

The marine shells (*Mya truncata* (Linné); identified by W. Blake, Jr.) were enclosed in fine sand. Sample 'DU-78-329 (22/7/4)' (GSC Locality No. O-107378) was collected by L.A. Dredge on July 22, 1978, from the Owl River, half-way between York Factory and Churchill, Manitoba (57°36'N, 93°32'W), at an elevation of 59.0 m. This sample was submitted by L.A. Dredge to gain information on sea level change.

Comment (W. Blake, Jr.): The dated sample comprised six right and six left valves, including at least two intact pairs. The remainder of the sample was fragments, but most included the truncated posterior end characteristic of this species. The largest valve was 4.0 cm long and probably close to 3 cm in height. Nearly all shells were less than 1 mm-thick, except in the hinge areas and at the truncated ends.

GSC-3856 Owl River II

normalized age: 5710 ± 80
corrected age: 5310 ± 80
$\delta^{13}C$= +1.40‰
uncorrected age: 5290 ± 80

The marine shells (*Astarte borealis* (Linné); identified by W. Blake, Jr.) were enclosed in sand. Sample 'DU-78-214 (15/7/2)' (GSC Locality No. O-107372) was collected by L.A. Dredge on July 15, 1978, from the Owl River, half-way between Port Nelson and Churchill, Manitoba (57°41'30"N, 93°21'30"W), at an elevation of 49.0 m. This sample was submitted by L.A. Dredge to gain information on sea level change.

Comment (W. Blake, Jr.): The shells in this sample were well preserved, although none of the 12 valves used retained the periostracum. All valves had good internal lustre and exhibited no

chalkiness. The sample consisted of seven left valves (5 intact, 2 fragments) and five right valves (4 intact, 1 fragment). Valves ranged in size between 3.3+ by 3.0 cm to 2.4 by 2.1 cm. The shells were, for the most part, less than 1 mm in thickness.

GSC-3896 Owl River III

normalized age: 5690 ± 70
corrected age: 5290 ± 70
$\delta^{13}C = +1.30‰$
uncorrected age: 5260 ± 70

The marine shells (*Chlamys islandica*; identified by W. Blake, Jr.) were enclosed in fine sand. Sample 'DU-78-83' (GSC Locality No. O-107367) was collected by L.A. Dredge on July 1, 1978, from the Owl River, 28 km from the river mouth, Manitoba (57°46'20"N, 93°11'W), at an elevation of 37.0 m. This sample was submitted by L.A. Dredge to gain information on sea level change, and rate of emergence.

Comment (L.A. Dredge): The stony diamicton probably represents an extensive period of increased ice rafting in Hudson Bay and/or a small sea level fluctuation. The top of the section is at an elevation of 37 m. The date was used in constructing an emergence curve for the region (Dredge and Cowan, 1989), and it also gives a maximum age for the time of ice rafting.

Comment (W. Blake, Jr.): The sample comprised six whole valves, ranging in size from 5.2 cm wide by 6.2 cm high to 3.4 cm wide by 3.8 cm high, plus numerous fragments. All shells were clean, with no incrustations or pitting. The nacreous layer (aragonite plus calcite) retained good lustre.

BGS-793 Churchill River I

uncorrected age: 3530 ± 100

The wood (log) was enclosed in silty clay. Sample 'Ch 6(a)' from 1.5 m depth was collected by E. Nielsen in June, 1981, from a natural river cut on the Churchill River, Manitoba (57°58'00"N, 95°00'00"W), at an elevation of about 90 m. This sample was submitted by E. Nielsen to gain information on sea level change, and isostatic uplift in northern Manitoba.

GX-1063 Churchill River II

uncorrected age: 8010 ± 95

The marine shells were collected by F.J.E. Wagner in 1965, along Churchill River, 80 km southwest of Churchill, Manitoba (58°06'N, 94°42'W), at an elevation of 67.1 m. This sample was submitted by F.J.E. Wagner to gain information on sea level change.

Comment (F.J.E. Wagner): The date is too old and not compatible with others (e.g. GSC-878) and is assumed to be redeposited and/or contaminated (cf. Craig in Lowdon and Blake, 1970).

GSC-92 southwest of Churchill

uncorrected age: 7270 ± 120

The marine shells (*Hiatella arctica*; identified by B.G. Craig), sample 'AC 5/60', were collected by J.D. Aitken in 1960, from 88 km southwest of Churchill, Manitoba (58°11'N, 95°03'W), at an elevation of 142 m. This sample was submitted by B.G. Craig to gain information on deglaciation, glacial retreat, and the initiation of the Tyrrell Sea.

Comment (B.G. Craig): The sample provides a minimum date for the retreat of Laurentide ice from this area and for entry of Tyrrell Sea into southwest Hudson Bay.

BGS-796 Deer River

uncorrected age: 5150 ± 110

The marine shells (*Chlamys islandicus*; identified by E. Nielsen) were enclosed in calcareous silt. Sample 'Ch-3' was collected by E. Nielsen in June, 1981, from the confluence of the Churchill and Deer rivers in northern Manitoba (58°21'30"N, 94°16'30"W), at an elevation of about 30 m. This sample was submitted by E. Nielsen to gain information on sea level change, and isostatic uplift in northern Manitoba.

GSC-3070 'Kennedy Rapids'

normalized age: 8170 ± 140
corrected age: 7770 ± 140
$\delta^{13}C = +1.30‰$
uncorrected age: 7750 ± 140

The marine shells, whole valves of *Hiatella arctica* (identified by L.A. Dredge) were enclosed in marine sand directly overlying till. Sample 'DU-79-13' was collected by L.A. Dredge on July 12, 1979, near the 'Kennedy Rapids' on the North Knife River, northeastern Manitoba (58°33'N, 95°50'W), at an elevation of 106 m. This sample was submitted by L.A. Dredge to gain information on sea level change, and the Hudsonian glacial readvance.

Comment (L.A. Dredge): The shells relate to an early phase of the Tyrrell Sea, but lie well below the marine limit, which is at about 150 m in this area. The date is substantially older than Craig's date of 7270 ± 120 years (GSC-92, above; Craig, 1969; Dyck and Fyles, 1964, p. 170) from a beach ridge near Churchill River at 141 m and is probably a better estimate of the beginning of marine submergence. The date is also older than any obtained from the Nelson River area to the south (cf. GSC-3326, 7180 ± 70 years; Nielsen and Dredge, 1982). The shell bed directly overlies till emplaced when Hudsonian ice readvanced into Lake Agassiz. The age of the sample gives an approximate time for this glacial activity, which marked the end of Lake Agassiz. The date agrees well with GSC-3348, 7760 ± 370 years (Nielsen and Dredge, 1982) on freshwater shells (presumably from Lake Agassiz) from Churchill River in this same general area.

Comment (W. Blake, Jr.): The sample was composed of 19 left and 32 right valves. The maximum size was >2.4 x 1.4 cm, and the smallest valve was 1.4 x 0.7 cm. Most valves were 2.0 to 2.2 cm long, with traces of periostracum and ligament as well as internal lustre.

GX-1072 southeast of Churchill

uncorrected age: 3190 ± 80

The marine shell sample was collected by F.J.E. Wagner in 1965, from 27 km southeast of Churchill, Manitoba (58°36.4'N, 93°39.4'W), at an elevation of 30.5 m. This sample was submitted by F.J.E. Wagner to gain information on sea level change.

See GX-1073 (below, p. 111) for comments.

GSC-685 Twin Lakes

uncorrected age: 3180 ± 140

The marine shells (*Mytilus edulis*; identified by B.G. Craig) were enclosed in gravel. Sample 'CD-25/66' was collected by B.G. Craig on August 25, 1966, from a ditch between Twin Lakes, 26.7 km southeast of the CNR station, Churchill, Manitoba (58°37'08"N, 93°48'40"W), at an elevation of 38.5 m. This sample was submitted by B.G. Craig to gain information on sea level change, and the rate of emergence.

Comment (B.G. Craig): The dates of this series indicate that for a period of about 3000 to 1000 years ago, the land around Churchill rose relative to the sea at a rate of about 1.5 m per 100 years. See GSC-1226 (below, p. 111) for additional comments.

GSC-735 Goose Creek

uncorrected age: 3430 ± 140

The marine shell fragments (*Chlamys islandicus*; identified by W. Blake, Jr.) were enclosed in stony silty clay in a channel dug in stream bed. Sample 'CD-13/66' was collected by B.G. Craig on August 22, 1966, from the mouth of Goose Creek at the Churchill River, 10.6 km southeast of the CNR station, Churchill, Manitoba (58°40'15"N, 94°10'12"W), at an elevation of 4.6 m. This sample was submitted by B.G. Craig to gain information on sea level change, and the rate of emergence.

Twin Lakes Road Series

A series of marine shell samples from a ditch on Twin Lakes road, 20.3 km east-southeast of the CNR station, Churchill, Manitoba (58°42'10"N, 93°50'35"W), at an elevation of 27 m, was collected by B.G. Craig on August 25, 1966. These samples were submitted by B.G. Craig to gain information on sea level change; and by R. McNeely as a crosscheck date.

GSC-683 Twin Lakes Road I

uncorrected age: 2320 ± 130

The marine shells, sample 'CD/24/60' (*Mytilus edulis*; identified by B.G. Craig) were enclosed in sandy gravel.

Comment (B.G. Craig): The dates of this series indicate that for a period about 3000 to 1000 years ago, the land around Churchill rose relative to the sea at a rate of about 1.5 m per 100 years.

GSC-683 2 Twin Lakes Road II

normalized age: 2640 ± 80
corrected age: 2240 ± 80
$\delta^{13}C = +2.87‰$
uncorrected age: 2200 ± 80

The marine shells, sample 'CD/24/60' (*Mytilus edulis*; identified by A.S. Dyke) were enclosed in sandy gravel.

Laboratory Comment (R. McNeely): In the late 1980s, a number of Terrain Sciences staff expressed a concern that some of the shell dates generated by the Laboratory in the 1960s were not consistent with new shell dates produced on material collected when sites were re-visited and shell material re-sampled. The new dates were often different by about 400 years, which was suspiciously close to the reservoir age assumed by GSC when shell dates are 'corrected' to 0.0‰ $\delta^{13}C$. This might suggest that the data had been reported differently in the past than now. Although there was no reason to suspect GSC shell dates (either then or now) it was decided to crosscheck some of B.G. Craig's original samples. A number of archived samples were located and where sufficient material was still available (although the quality of the some of the archived samples was poor) the sample was re-dated. Six samples ranging in age from about 2 to 9.5 ka that were processed between 1961 and 1966 were re-dated in 1990 and the new ages were compared with the original dates. Because the original samples did not have a $\delta^{13}C$ measured, the 'uncorrected' ages should be compared to ascertain whether there is any problem with GSC shell dates. The tabulation below indicates good agreement between the sample splits. All age differences were within 5% of the age, and half the differences were less than 1% of the age; all, but one, were within their combined errors.

Laboratory No.	GSC-39	GSC-47	GSC-241
Orig (Uncor.)	9440 ± 120	8700 ± 120	9280 ± 150
New (Uncor.)	9460 ± 80	8720 ± 80	9440 ± 90
$\delta^{13}C$ (‰)	+ 1.83	+ 0.33	+ 1.41
Normalized	9890 ± 80	9130 ± 80	9860 ± 90
Corrected	9490 ± 80	8730 ± 80	9460 ± 90

Laboratory No.	GSC-286	GSC-392	GSC-683
Orig (Uncor.)	6850 ± 140	9260 ± 150	2320 ± 130
New (Uncor.)	7080 ± 120	9240 ± 90	2200 ± 80
$\delta^{13}C$ (‰)	+ 2.52	+ 0.73	+ 2.87
Normalized	7520 ± 120	9650 ± 90	2640 ± 80
Corrected	7120 ± 120	9250 ± 90	2240 ± 80

GSC-1549 CNR station

normalized age: 5450 ± 140
corrected age: 5050 ± 140
$\delta^{13}C = +2.20‰$
uncorrected age: 5020 ± 140

The marine shells, whole valves and fragments of *Chlamys islandicus* (identified by W. Blake, Jr.), sample 'CD-16/66' from about 1.5 m depth, were collected by B.G. Craig on August 23, 1966, from a ditch in a roadcut, about 6.5 km southeast of CNR station, Churchill, Manitoba (58°44'25"N, 94°04'35"W), at an elevation of 22 m. This sample was submitted by B.G. Craig to gain information on sea level change.

Comment (B.G. Craig): The date is 3000 years older than *Mytilus edulis* (GSC-723, below, p. 111) collected in the same area also at 22 m asl.

GSC-261 Churchill airport

uncorrected age: 3040 ± 130

The marine shells, whole valves and fragments of *Mytilus edulis* (identified by J.G. Fyles), were enclosed in gravel and sand. Sample '16344 (24F)' was collected by E.B. Owen in 1948, from the west side of the airport at Churchill, Manitoba (58°44'30"N, 94°04'50"W), at an elevation of about 23 m. This sample was submitted by J.G. Fyles to gain information on sea level change, and the rate of emergence.

GSC-682 Rocket Range road

uncorrected age: 1240 ± 130

The marine shells (*Mytilus edulis*; identified by B.G. Craig) were enclosed in gravel. Sample 'CD-21/66' was collected by B.G. Craig on August 24, 1966, from a ditch on Rocket Range road, 19.5 km east of the CNR station, Churchill, Manitoba (58°44'45"N, 93°50'25"W), at an elevation of 10.5 m. This sample was submitted by B.G. Craig to gain information on sea level change, and the rate of emergence.

Comment (B.G. Craig): The dates of this series indicate that for a period of about 3000 to 1000 years ago, the land around Churchill rose relative to the sea at a rate of about 1.5 m per 100 years.

GSC-1226 Cape Churchill

uncorrected age: modern
$\delta^{13}C = +1.90‰$

The marine shells (*Mytilus edulis*; identified by W. Blake, Jr.) were a live collection on the bottom of the intertidal zone. Sample 'CD-143-1/67' was collected by B.G. Craig on August 27, 1967, from Cape Churchill, 58 km east of Churchill, Manitoba (58°45'N, 93°12'W). This sample was submitted by B.G. Craig to gain information on the post-bomb marine reservoir age.

Comment (B.G. Craig): The date confirms the modern age of recently living shells. Five dates on *Mytilus edulis* shells from emergent strandline sediments, GSC-682, -683, -685, -723, plus GX-1065, altitude 38 m, (Wagner, 1967) indicate that for a period of between about 3 ka and 1 ka BP the land around Churchill rose relative to sea level at a rate of about 1.5 m per century (Craig, 1969). GSC-261, and -735 are anomalous and may represent deposition in deep water, redeposition of older material, or a mixture of materials of various ages.

GX-1073 east of Churchill

uncorrected age: 385 ± 80

The marine shells were collected by F.J.E. Wagner in 1965, from 32 km east of Churchill, Manitoba (58°45'N, 93°21'W), at an elevation of 3.7 m. This sample was submitted by F.J.E. Wagner to gain information on sea level change.

Comment (F.J.E. Wagner): This date was plotted by Wagner (1967) on an age versus elevation curve of the region along with GX-1065 and -1073. The curve parallels, but is some what younger than the uplift curve for James Bay, and parallels but is somewhat older than the uplift curve for areas north of Hudson Bay. Thus, samples of corresponding ages are found at higher elevations in the southern part of the area than in the northern part.

S-738 Button Bay

uncorrected age: 3560 ± 105

The marine shells were enclosed in gravel on a quartzite ridge below occupation level pre-Dorset Eskimo houses. Sample 'CMC-395', from 10.1-15.2 cm depth, was collected by R.J. Nash and D.A. Meyer in 1968, from the east shore of Button Bay on the west side of the Churchill River across from Churchill, Manitoba (58°45'N, 94°15'W), at an elevation of 35 m. This sample was submitted by D.A. Meyer to gain information on sea level change and the geoarchaeology of the site.

Comment (D.A. Meyer): The date should indicate the time when Hudson Bay waters were at ridge level (35 m).

GSC-4507 'rock ridge'

uncorrected age: 2380 ± 100

The marine shells (*Macoma baltica*; identified by L.A. Dredge) were enclosed in beach sand. Sample 'DU-87-01' (GSC Locality No. O-107485) was collected by L.A. Dredge and E. Nielsen on August 14, 1987, from the north side of the coast road at the base of a rock ridge 2.5 km east of the town of Churchiil, Manitoba (58°45.1'N, 94°08.6'W), at an elevation of 7 m. This sample was submitted by L.A. Dredge to gain information on sea level change.

Comment (L.A. Dredge): The shells were collected from an excavation on the Erickson property. The date indicates that sea level stood at the site about 2.4 ka ago.

GSC-245 Churchill River

uncorrected age: 3080 ± 130

The peat was enclosed in muskeg overlying alluvial sand and gravel, and marine sediments. Sample 'PL-62-1 a' was collected by N.W. Radforth on September 1, 1948, from the right bank of Churchill River, near CNR tracks, west of the airport and south of Churchill, Manitoba (58°45'10"N, 94°08"W), at an elevation of 4.5 to 5 m. This sample was submitted by J. Terasmae to gain information on sea level change, and the rate of emergence.

GSC-723 Rocket Range road

uncorrected age: 2120 ± 130

The marine shells (*Mytilus edulis*; identified by W. Blake, Jr.) were enclosed in sand. Sample 'CD-29/66' was collected by B.G. Craig on August 25, 1966, from a gravel pit on Rocket Range road, 10.9 km east of the CNR station, Churchill, Manitoba (58°45'25"N, 93°58'50"W), at an elevation of 22 m. This sample was submitted by B.G. Craig to gain information on sea level change, and the rate of emergence.

GSC-684 Rocket Range road

uncorrected age: 1020 ± 140

The marine shells (*Mytilus edulis*; identified by B.G. Craig) were enclosed in pebbly sand. Sample 'CD-30/66' was collected by B.G. Craig on August 25, 1966, from a pit on Rocket Range road, 13 km east of the CNR station, Churchill, Manitoba (58°45'35"N, 93°57'00"W), at an elevation of 6.5 m. This sample was submitted by B.G. Craig to gain information on sea level change, and the rate of emergence.

Comment (B.G. Craig): These dates GSC-723 and -684 indicate that for a period of about 3000 to 1000 years ago, the land around Churchill rose relative to the sea at a rate of about 1.5 m per 100 years.

GSC-3851 North Knife River

normalized age:	4420 ± 90
corrected age:	4020 ± 90
	$\delta^{13}C$= +1.30‰
uncorrected age:	4000 ± 90

The marine shell fragments (*Mytilus edulis* (Linné); identified by W. Blake, Jr.) were enclosed in silt. Sample 'DU-78-64 (29/6/9)' (GSC Locality No. O-107366) was collected by L.A. Dredge on June 29, 1978, from 21 km from the mouth of the North Knife River, northwest of Churchill, Manitoba (58°53'30"N, 94°58'W), at an elevation of 30.0 m. This sample was submitted by L.A. Dredge to gain information on sea level change.

Comment (W. Blake, Jr.): Most of the sample dated consisted of fragments of *Mytilus edulis*. The largest valve of this species remaining in the sample measured 6.0 by 2.8 cm. The large valves are generally less than 1.00 mm in thickness, but smaller valves are thinner.

GSC-2556 Clarke River

uncorrected age:	modern

The wood, a twig of *Alnus* (identified by R.J. Mott (unpublished GSC Wood Report No. 77-49)) was enclosed in sandy deltaic deposits. Sample 'DU-77-235 9/7/8' (GSC Locality No. O-107359) from a depth of 5.5 m was collected by L.A. Dredge and M.F. Nixon on July 9, 1977, from the south bank of the Clarke River between the Caribou and Seal rivers, northern Manitoba (59°18'N, 95°23'W), at an elevation of 90 m. This sample was submitted by L.A. Dredge to gain information on sea level change.

Comment (L.A. Dredge): This date is anomalously young. Marine shells from the same stratigraphic position have been dated at 6570 ± 100 years (GSC-2579) and provide an approximate age for the 90 m sea level.

GSC-2579 Caribou River

normalized age:	7190 ± 100
corrected age:	6790 ± 100
	$\delta^{13}C$= +2.50‰
uncorrected age:	6750 ± 100

The marine shells, whole valves of *Hiatella arctica* (identified by W. Blake, Jr.) were enclosed in stratified deltaic deposits of silty sand. Sample 'DU-77-235 A' (GSC Locality No. O-107359) was collected by L.A. Dredge and E. Nielsen on July 9, 1977, from the Caribou River, Manitoba (59°18'N, 95°23'W) at an elevation of 85 m. This sample was submitted by L.A. Dredge to gain information on sea level change, specifically emergence.

Comment (L.A. Dredge): The sample was taken from stratified deltaic deposits of silty sand, which relate to a sea level at about 90 m. The date does not fit well onto the smoothed emergence curve for the Churchill area. The discordant fit suggests that the emergence history for this area, which was under the influence of the Keewatin ice regime, differs from that of the Churchill area, which was additionally affected by Hudsonian ice.

Comment (W. Blake, Jr.): The sample used for dating comprised 26 right valves and 17 left valves; the largest measured 3.1 x 1.7 cm, the smallest 1.0 x 0.5 cm. The shell exteriors were somewhat chalky, but a good internal lustre was retained. Some valves were worn, others were not worn and had bits of periostracum intact. No pitting was evident, but a few shells were slightly discoloured (perhaps with thin encrusting matter).

GX-1065 Churchill River mouth

uncorrected age:	2800 ± 110

The marine shells were a surface collection on an emergent strandline. The sample was collected by F.J.E. Wagner in 1965, from the left bank, at the mouth of the Churchill River, Manitoba (58°45'N, 94°16.5'W), at an elevation of 38.1 m. This sample was submitted by F.J.E. Wagner to gain information on sea level change.

Comment (F.J.E. Wagner): Date indicates, along with others (e.g. GSC-682) "that for period about 3000 to 1000 years ago land around Churchill rose relative to sea at rate of about 1.5 m per 100 years" (Craig, 1969). GX-1072 and GX-1073 also fit the regional uplift curve.

RADIOCARBON DATES RELATED TO GLACIAL LAKE AGASSIZ

Radiocarbon Dates related to the Morris Phase (Fig. 10a)

GSC-4950 Buffalo Point I

normalized age: 9340 ± 80
$\delta^{13}C$= -26.4‰
uncorrected age: 9360 ± 80

The wood (*Picea*; identified by R.J. Mott (unpublished GSC Wood Report No. 90-09)) was enclosed in sand. Sample 'BP-89-3' was collected by E. Nielsen and G. Matile on June 19, 1989, from 1.5 km west of Buffalo Point on Lake of the Woods, Manitoba (49°00'04"N, 95°15'11"W), at an elevation of 323 m. This sample was submitted by E. Nielsen to gain information on the McCauleyville level, Morris Phase, of Lake Agassiz.

GSC-4933 Buffalo Point II

normalized age: 9400 ± 100
$\delta^{13}C$= -26.6‰
uncorrected age: 9430 ± 100

The wood (*Picea*; identified by H. Jetté (unpublished GSC Wood Report No. 90-08)) was enclosed in sand. Sample 'BP-89-1' was collected by E. Nielsen and G. Matile on June 19, 1989, from 0.8 km west of Buffalo Point on Lake of the Woods, Manitoba (49°00'06"N, 95°14'36"W), at an elevation of 323 m. This sample was submitted by E. Nielsen to gain information on the McCauleyville level, Morris Phase, of Lake Agassiz.

Comment (G. Matile): Samples GSC-4933 and -4950 were collected from the base of a 1.7 km long spit, consisting of westward dipping 3 m high foreset beds. The water level at the time of deposition was 327 m, i.e. one meter above the spit surface. This level is interpreted as the McCauleyville strandline of Lake Agassiz. The 60 years between these two dates may represent the time required for the spit to migrate 700 m westward. Elson's 1964 site (GSC-391, Lowdon, et al, 1967) is located at the east end of the spit. Although no organics associated with GSC-391 were found, Elson's upper sand and gravel unit is correlated with the McCauleyville spit. The unit correlating with GSC-391 (9990 ± 160), being bound by laminated sediments, represents the Moorhead disconformity.

BGS-724 St. Malo

uncorrected age: 30 000 ± 2500

The freshwater shells (unidentified) were enclosed in horizontally bedded silty clay and pebbly sand overlying silty till. Sample 'G 203' was collected by G. Matile on July 21, 1980, from 4 km southeast of St. Malo, about 30 km from Steinbach, southeastern Manitoba (49°17'14"N, 96°55'00"W), at an elevation of about 270 m. This sample was submitted by G. Matile to gain information on the Gladstone level, Morris Phase, of Lake Agassiz.

Comment (G. Matile): The sample was collected from a depth of 1-1.5 m in a hand-dug hole. The sample was collected above the water table and recent roots were found throughout the enclosing material. The elevation of the sample (about 268 m) indicates the deposit was laid down when Lake Agassiz was at the Gladstone level. The anomalous age suggests probable Paleozoic / Mesozoic contamination in the sample.

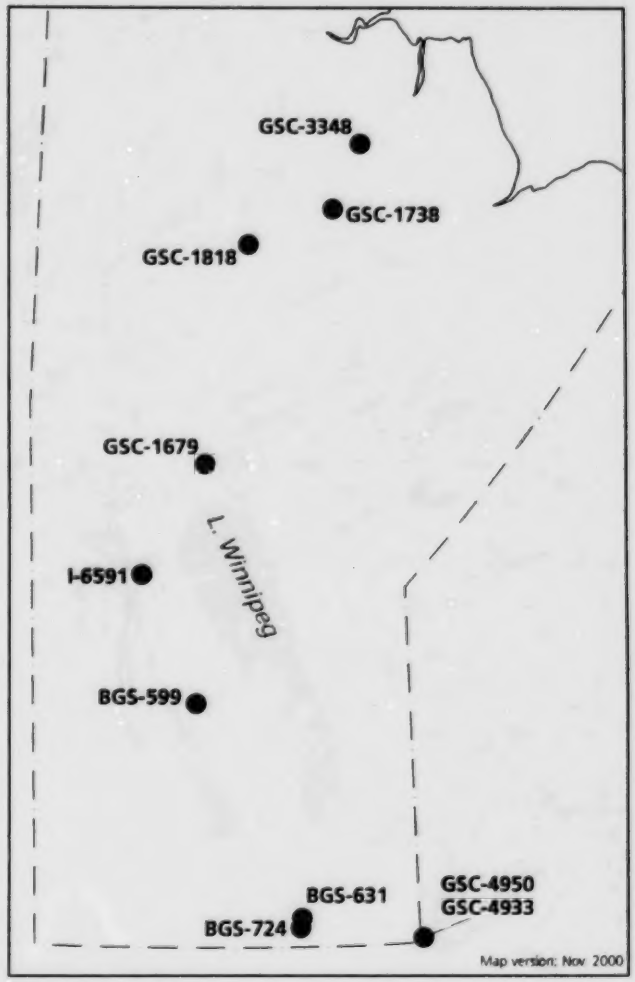

Figure 10a. Radiocarbon dates on the lake phases of Glacial Lake Agassiz: Morris Phase.

BGS-631 La Rochelle

uncorrected age: 17 000 ± 1700

The freshwater shells (unidentified) were enclosed in horizontally bedded pebbly sand and gravel with poorly defined cross-bedded gravel. Sample 'GM 318' was collected by G. Matile on October 15, 1979, from a gravel pit, 2.5 km east of La Rochelle, southeastern Manitoba (49°21'14"N, 96°55'12"W), at an elevation of about 262 m. This sample was submitted by G. Matile to gain information on the Ossawa level, Morris Phase, of Lake Agassiz.

Comment (G. Matile): The sample was collected from a recently opened gravel pit. The enclosing material is the uppermost unit in the pit with a thickness of about 2 m. The sample was collected above the water table and recent roots were found throughout the enclosing material. Horizontally bedded sand and gravel with some areas of poorly defined cross-bedded gravel suggest that the environment of deposition was a beach. The elevation of the sample (about 262 m) indicates the deposit was laid down when Lake

Agassiz was at the Ossawa level. The anomalous age suggests probable Paleozoic / Mesozoic contamination in the sample.

BGS-599 Gypsumville

uncorrected age: 9470 ± 500

The freshwater shells, bivalve fragments possibly of Unionidae, were enclosed in a 2 m silty clay with shells. Sample 'EN-339' from about 1.5 m below the top was collected by E. Nielsen on July 26, 1978, from a drainage ditch and roadcut along highway 611, 4 km west of Gypsumville, Manitoba (51°46'10"N, 98°41'55"W). This sample was submitted by E. Nielsen to gain information on the lower The Pas level, Morris Phase, of Lake Agassiz.

Comment (E. Nielsen): This sample probably dates the lower The Pas waterplane of Lake Agassiz.

I-6591 The Pas moraine

uncorrected age: 7220 ± 110

The basal lake sediment was enclosed in calcareous sand. The sample from 200-210 cm depth was collected by J.C. Ritchie in 1970, from a shallow lake on The Pas moraine, 40 km west-southwest of Grand Rapids, Manitoba (53°02'N, 99°43'W). This sample was submitted by J.C. Ritchie to gain information on the Morris Phase, of Lake Agassiz, and deglaciation and pollen zone 2GR1.

Comment (J.C. Ritchie): This sample provides a minimum date for recession of Lake Agassiz from The Pas end moraine.

GSC-1679 Minago Ridge

normalized age: 8640 ± 170
$\delta^{13}C$= -4.52‰
uncorrected age: 8310 ± 180

The freshwater shell, a whole valve of *Lampsilis radiata* (identified by R. Green and A.H. Clarke, Jr.), was enclosed in gravel overlain by coarse beach gravels and windblown silty sand. Sample 'T13K' from 3.2 m depth was collected by S. Ringrose in July, 1971, from 1.6 km east of highway 6 and south of Minago Ridge, Manitoba (54°10'N, 98°50'W), at an elevation of 245 m. This sample was submitted by S. Ringrose to gain information on the Morris Phase of Lake Agassiz.

Comment (S. Ringrose): The sample was taken from the lowest known shoreline of Lake Agassiz, which suggests that a minimal terminal date for the draining of Lake Agassiz may coincide more closely with GSC-92 (7720 ± 120 years on marine shells southwest of Churchill; Dyck and Fyles, 1964, p. 170) than with GSC-896 (8530 ± 220 years on marine shells; Lowdon and Blake, 1970, p. 64; cf. Elson, 1967; Ringrose, 1975). Both are presented above in the section on Sea Level change.

GSC-1818 Settee moraine ridge

uncorrected age: 6920 ± 150

The lake sediment, basal organic debris with wood fragments of *Salix, Picea* or *Larix* (identified by R.J. Mott), was enclosed in coarse organic debris overlying sand, and 7 cm below sharp contact with algal gyttja. Sample 'MS-72-7' from 172-177 cm depth was collected by R.J. Mott on July 7, 1972, from a small unnamed kettle lake on Settee moraine ridge, 64 km north of Thompson, northern Manitoba (56°21'N, 97°57.5'W), at an elevation of about 305 m. This sample was submitted by R.J. Mott to gain information on the Morris Phase related to Lake Agassiz drainage, and peat accumulation.

Comment (R.J. Mott): The sample dates the beginning of organic accumulation in the kettle hole and is a minimum for deglaciation and for the draining of the local phase of Glacial Lake Agassiz which washed the morainic ridge (Mott, 1973).

GSC-1738 Recluse Lake

uncorrected age: 6490 ± 170

The basal peat was enclosed in peat overlying a clay-veneered till plain. Sample 'KJ-23-72' from 1.8 m depth was collected by R.W. Klassen on June 24, 1972, from a bog near Recluse Lake, adjacent to the upper reaches of the Little Churchill River, 88 km northwest of Gillam, Manitoba (56°52'N, 95°47'W), at an elevation of 185 m. This sample was submitted by R.W. Klassen to gain information on the Morris Phase of Lake Agassiz, and peat accumulation.

Comment (R.W. Klassen): A peat sample at the bottom of a perennially frozen bog 1.8 m-thick over a clay-veneered till plain was taken for dating. The sample was dated to obtain a more precise time for the drainage of Lake Agassiz in this region and to determine the rate of bog development (Klassen and Netterville, 1973). The age indicates that Lake Agassiz had drained from this area more than 6500 years ago and that the bog developed at a rate of 0.3 m per 1000 years.

GSC-3348 Churchill River

normalized age: 8070 ± 370
$\delta^{13}C$= -5.40‰
uncorrected age: 7760 ± 370

The freshwater shells, whole valves and fragments of *Sphaerium* (identified by L.A. Dredge), were enclosed in sand. Sample 'E.N.-7(b)' was collected by E. Nielsen on June 10, 1981, from the Churchill River, northeastern Manitoba (57°40'N, 95°25'W), at an elevation of 134 m. This sample was submitted by L.A. Dredge to gain information on the Morris Phase of Lake Agassiz drainage, and the initiation of the Tyrrell Sea.

Comment (L.A. Dredge): The date establishes a minimum age for the draining of Lake Agassiz from northeastern Manitoba. The terrace from which the sample was collected is tentatively correlated with a Tyrrell Sea beach at an elevation of 128 m which has been dated at 7770 ± 140 years BP (GSC-3070 in the section on 'Sea Level' change).

Comment (W. Blake, Jr.): The aragonitic shells were thin and well preserved. Most of the shells were intact valves but some fragments were present also.

Radiocarbon Dates related to the Emerson Phase (Fig. 10b)

GSC-391 Buffalo Point

uncorrected age: 9990 ± 160

The wood fragments were enclosed in sand underlying clayey silt with sand partings, and overlying laminated clay and till. Sample 'EB 68-8-26' was collected by J.A. Elson on August 25, 1964, from base of wave-cut cliff in Indian Reserve Number 36, on the south side and about 370 m west of Buffalo Point, Lake of the Woods, Manitoba (49°00'N, 95°14'W), at an elevation of about 323 m. This sample was submitted by J.A. Elson to gain information on the lower Campbell level, Emerson Phase, of Lake Agassiz.

The sample was from horizontal partings of organic matter (wood, bark, clam-shell fragments) within a 0.6 m-thick sand bed, and overlain in succession by 0.5 to 0.6 m of clayey silt with sand partings and 1.2 m of fine sandy pebble gravel, and underlain by laminated clay and till. Modern rootlets penetrate the organic layer but form no more than 5% of the sample. Sand and gravel overlying the dated layer form a wave-built terrace probably constructed from ice-contact stratified drift when water level here stood about 14 to 18 m higher than Lake of the Woods (altitude 323 m), probably during the phase of Lake Agassiz represented by beach ridges at about 337 to 341 m near Harris Hill, Ontario on the east side of Lake of the Woods. These are on Isobase No. 6 of Johnston (1946) and appear to be his lower Campbell strandline.

Comment (J.A. Elson): The sample dates the lower Campbell strandline, perhaps formed when Lake Agassiz discharged northwest via Turnor Lake through Clearwater valley in northwestern Saskatchewan. Cf. dates from North Dakota: W-900, Grand Forks, 10 080 ± 280 (W-VI); W-993, Fargo, 9900 ± 400 (W-VII); and W-1005, Thompson, 10 050 ± 300 (W-VII).

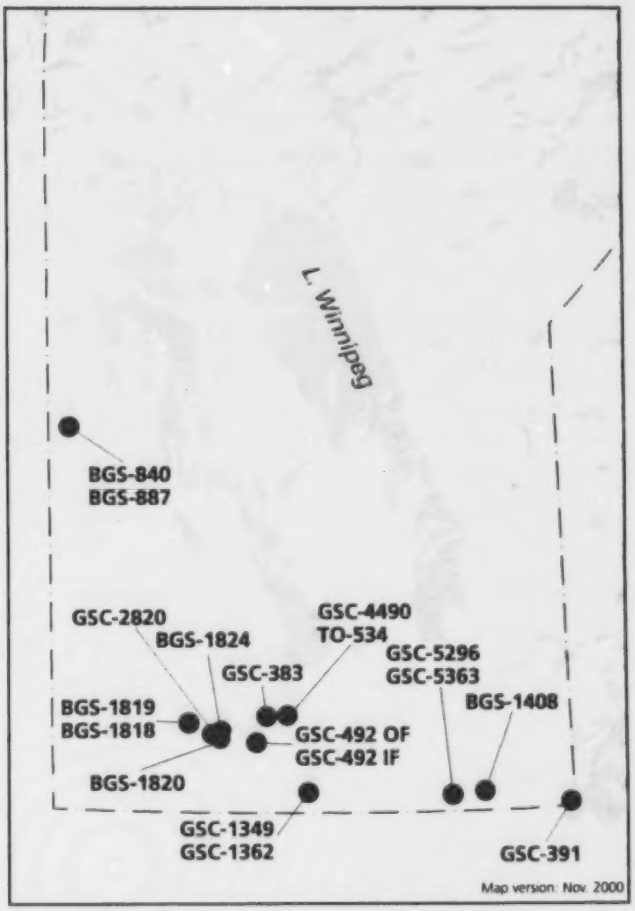

Figure 10b. Radiocarbon dates on the lake phases of Glacial Lake Agassiz: Emerson Phase.

Vita Series

A series of samples from 3.5 km northeast of Vita, southeastern Manitoba (49°09'48"N, 96°32'46"W), at an elevation of 303 m, was collected by G. Matile on August 8, 1991. These samples were submitted by G. Matile to gain information on the Emerson Phase of Lake Agassiz.

GSC-5296 Vita I

normalized age: 10 000 ± 90
$\delta^{13}C$= -28.7‰
uncorrected age: 10 100 ± 90

The wood sample 'G-983' from 2.4 m depth (*Picea*; identified by H. Jetté (unpublished GSC Wood Report No. 91-62)) was enclosed in terrestrial plant remains in silt (organic mud).

GSC-5363 Vita II

normalized age: 10 900 ± 100
$\delta^{13}C$= -5.61‰
uncorrected age: 10 600 ± 100

The freshwater bivalve shells, sample 'G-983', were enclosed in sand-clay rhythmites.

Comment (G. Matile): Wood (GSC-5296, above and -5731, below, p. 119) and shells (GSC-5363) were collected from a backhoe pit dug within a drowned Moorhead Phase river channel. The wood was enclosed by terrestrial plant remains associated with the river channel, while the shells were from overlying sand-clay rhythmites associated with the initial inundation of the channel by the rising water of the Emerson Phase of Lake Agassiz.

BGS-1408 Rat River

uncorrected age: 9770 ± 110

The wood was enclosed in unoxidized saturated silty sand. Sample 'G 764' was collected by G. Matile on August 7, 1989, from flood the levees parallelling the Rat River, just beyond where river cuts the lower Campbell strandline, 8 km southeast of Lonesand on highway 12, southeast Manitoba (49°11'02"N, 96°12'56"W), at an elevation of 330 m. This sample was submitted by G. Matile to gain information on the Campbell level, Emerson Phase, of Lake Agassiz.

Comment (G. Matile): A backhoe test pit was excavated on the sampling date. The sample was taken from below the watertable in unoxidized saturated sediment. These alluvial sediments may be contemporaneous with the lower Campbell strandline. The dunes within the river channel upstream from the sample site suggest that major quantities of water have not passed through the channel for several thousand years.

Thornhill Terrace Series

A series of samples from the Thornhill Terrace, 2.4 km north of Thornhill and 8 km west of Morden, Manitoba (49°13.7'N, 98°13.6'W), at an elevation of about 375 m, was collected by L.D. Delorme in July, 1969. This sample was submitted by L.D. Delorme to gain information on the Emerson Phase of Lake Agassiz, and the fluviolacustrine environment.

The Thornhill Terrace site is a fluviolacustrine deposit. The surface of the terrace is at an altitude of about 375 m (calculated from a topographic map). The sediments were deposited in this small tributary channel when Lake Agassiz was first formed adjacent to the Pembina Uplands, and they have been exposed by subsequent downcutting. Samples were obtained from a road cut, about 0.9 m below the natural face.

GSC-1362 Thornhill Terrace I

uncorrected age: 8740 ± 160

The organic detritus sample '19-65-69' from 198.1-200.8 cm depth was enclosed in fluviolacustrine sediments.

Comment (L.D. Delorme): No shelled invertebrates were recovered from this uppermost organic-rich layer.

GSC-1349 Thornhill Terrace II

uncorrected age: 9400 ± 150

The organic detritus sample '19-86-69' from 262.1-264.8 cm was enclosed in fluviolacustrine deposits.

Comments (L.D. Delorme): Analysis of shelled invertebrates from the middle organic-rich layer indicates a shallow, intermittent stream draining from the forested uplands into Lake Agassiz.

GSC-2820 Stockton Ferry

uncorrected age: 980 ± 60

The wood (*Fraxinus*; identified by R.J. Mott (unpublished GSC Wood Report No. 79-04)) was enclosed in blue-grey fossiliferous clay, with minor pebbles below sand, or paleosol. Sample 'AR-12' was collected by S. Ringrose on August 24, 1978, near Stockton Ferry on the Assiniboine River, 4.8 km west of Chaucer, Manitoba (49°38'N, 99°30'W; GSC Locality No. O-107806), at an elevation of about 320 m. This sample was submitted by S. Ringrose to gain information on the lake level change of Lake Agassiz.

The shell-bearing clay, extending to about 2 m above the level of the Assiniboine River, was 6+ m below the ground surface. The strata immediately above the clay are obscured by slumping; above, in succession, are clay with sand, or paleosol, coarse sand and horizontally bedded pebble gravel, clay, medium sand, and gravel.

Comments (S. Ringrose): The age expected by the submitter was 13 to 14 ka BP, as the sample was thought to complement the Thornhill Terrace series (cf. Lowdon and Blake, 1976, p. 8) with respect to the inception of Lake Agassiz I in Manitoba. The pollen assemblage, however, suggested an age of less than 10 ka BP (unpublished GSC Palynological Report No. 79-1 by R.J. Mott). The wood must relate to the slumped materials rather than to a horizon below the paleosol.

Holland Series

A series of samples from a terrace, 15 m above the Assiniboine River flats, about 10 km north of Holland, Manitoba (49°36'N, 98°56'W; GSC Locality No. O-107929; NE 1/4 sec. 28, tp. 8, rge. 11, W prin. mer.), at an elevation of 320 m, was collected by R.W. Klassen on September 15, 1965. These samples were submitted by R.W. Klassen to gain information on the upper Campbell level, Emerson Phase, of Lake Agassiz.

GSC-492 OF Holland I

uncorrected age: 10 700 ± 160

GSC-492 IF Holland II

uncorrected age: 10 670 ± 160

The freshwater pelecypod shells, sample 'KJ-13-65' from 1.5 m below the terrace surface were enclosed in silt.

Comment (R.W. Klassen): The altitude indicates that the deposit correlates with the highest Campbell beach of Lake Agassiz II.

BGS-1820 Glenboro

uncorrected age: 8610 ± 100

The freshwater shells were enclosed in highly calcareous sand. Sample 'ASSR95-16' from 3 m depth was collected by E. Nielsen, G. Matile and L.H. Thorleifson on June 29, 1995, from a section along the Assiniboine River, 8 km north of Glenboro, Manitoba (49°38'08"N, 99°16'30"W), at an elevation of about 325 m. This sample was submitted by E. Nielsen to gain information on the Campbell level, Emerson Phase transgression, of Lake Agassiz.

Comment (E. Nielsen): A 9 m-high section composed of basal till, silty clay, pebbly sand, and capped by silt in a point bar sequence was present at the site.

BGS-1824 Steels Ferry

uncorrected age: 6350 ± 150

The bone was enclosed in highly calcareous silt. Sample 'ASSR95-17' from 1 m depth was collected by E. Nielsen, G. Matile and L.H. Thorleifson on June 29, 1995, from a river-bank section along the Assiniboine River, 2 km west of Steels Ferry, Manitoba (49°42'03"N, 99°15'15"W), at an elevation of about 320 m. This sample was submitted by E. Nielsen to gain information on the Campbell level, Emerson Phase, of Lake Agassiz.

Comment (E. Nielsen): A 10 m-high section composed of silt over pebbly sand over silty clay of point bar sequence in a well developed terrace was present at the site.

Wawanesa Series

A series of samples from a river-bank section along the Assiniboine River, Manitoba (49°44'57"N, 99°40'43"W), at an elevation of 300 to 345 m, was collected by E. Nielsen, G. Matile and L.H. Thorleifson on June 26 and 28, 1995. These samples were submitted by E. Nielsen to gain information on the Norcross level, Emerson Phase, of Lake Agassiz.

BGS-1818 Wawanesa

uncorrected age: 8280 ± 100

The freshwater shells, sample 'ASSR95-01-B', from 3 m depth were enclosed in sandy silt with abundant limestone clasts. This site was 17 km north of Wawanesa.

The calibrated age is 9250 ± 100.

Comment (E. Nielsen): A 5 m-high section composed of a point bar sequence was present at the site.

BGS-1819 Terherne

uncorrected age: 11 625 ± 130

The freshwater shells, sample 'ASSR95-14', from 3 m depth were enclosed in highly calcareous silt. This site was 13 km north of Terherne.

The calibrated age is 13 550 ± 130.

Comment (E. Nielsen): A 25 m-high section composed of basal till, clay (12 m), sand (4 m), silt (3 m), and capped by 1 m of clay was present at the site.

GSC-383 Lavenham

uncorrected age: 10 600 ± 150

The marl sample 'EB-64-7-17' was collected by J.A. Elson on August 17, 1964, from Lonsbury Farm, on the west side of a small gully tributary to Assiniboine River, 3.2 km south and 2 km west of Lavenham, Manitoba (49°45.8'N, 98°45.2'W), at an elevation of 320 m. This sample was submitted by J.A. Elson to gain information on the Campbell level, Emerson Phase, of Lake Agassiz, and to provide a crosscheck date.

The sample was from the middle of a white marl bed 1.4 m-thick, underlying 2.2 m of fine sand and silt rich in aquatic snail shells (Mozley, 1934) and overlying at least 2.4 m of silt and sand. The wood layer that yielded Y-411 (10 550 ± 200, Barendsen et al., 1957) is about 0.8 m below the base of marl and 1.5 m below GSC-383.

Comment (J.A. Elson): The sample was dated to check the reliability of marl for dating Glacial Lake Agassiz. It should be slightly younger than Y-411, but the age difference is well within statistical counting error; hence agreement is excellent. Note also, the close agreement with GSC-492 (above) for pelecypod shells from a related deposit. The date relates to the main Campbell phase of Glacial Lake Agassiz.

Rossendale Series

A series of samples from a gully site, 4.8 km south and 1.6 km east of Rossendale, Manitoba (49°47'N, 98°35'36"W; SW1/4 LSD 4, Sec. 35, Tp. 9, Rge. 9, W-P. Mer.), at an elevation of 328 m, was collected by R.W. Klassen and J.T. Teller on October 4, 1986. These samples were submitted by R.W. Klassen to gain information on the Campbell level, the initiation of the Emerson Phase, of Lake Agassiz.

TO-534 Rossendale I

normalized age: 9600 ± 70

The wood fragments, sample 'KJ-318-86' (*Picea* and *Salix*?; identified by R.J. Mott (unpublished GSC Wood Report No. 87-26)), were enclosed in peat with marl and sand.

The age is normalized to a $\delta^{13}C$ of -25‰.

GSC-4490 Rossendale II

normalized age: 9510 ± 90
$\delta^{13}C$= -26.9‰
uncorrected age: 9540 ± 90

The wood sample 'KJ-318-86' (*Picea* and *Salix*?; identified by R.J. Mott (unpublished GSC Wood Report No. 87-26)), was enclosed in peat associated with marl and sand.

Comment (R.W. Klassen): The wood (*Salix*) sample was recovered from a back-hoe excavation at a depth of about 3 m. The site was located in a shallow gully across the front of the Assiniboine Delta just behind the 9.5 to 10 ka Campbell Beach. Ostracodes from the sediments suggest a permanent pond environment (Delorme, 1986) which was most likely a backwater between the Campbell Beach and the Delta front. A study of the associated pollen indicates a spruce / pine transition (Mott, per. comm.). Two previous dates of about 12.4 ka (Y-165) and 12.1 ka (GSC-1319, Lowdon, et al., 1971) on the peat from these sediments were assumed to provide a minimal age for the delta. This wood date and a similar date from the same sample (TO-534), and the local stratigraphic - geomorphic relationships indicate a direct relationship to the Campbell Beach and terraces of the same age within the Assiniboine Valley across the delta (Klassen, 1984). Recognition of the Campbell Beach phase and earlier Assiniboine Delta phase as separate events is crucial to deciphering the late glacial history of this region. Questionable interpretations have resulted where this aspect of developmental history has been overlooked (Teller, 1989).

Hubbell Creek Series

A series of samples from a gravel pit (D), near Hubbell Creek, 13 km northwest of the town of Swan River on the flanks of Porcupine Hills, west central Manitoba (52°11'18"N, 101°25'15"W), at an elevation of 351 m, was collected by E. Nielsen and E.M. Gryba on July 16, 1978. These samples were submitted by E. Nielsen to gain information on the lower Campbell level, Emerson Phase, of Lake Agassiz.

BGS-887 Hubbell Creek I

uncorrected age: 9400 ± 125

The bison bone, sample 'Bone No. 3', was found in gravel-spit deposits in gravel pit D. The abraded bone, from a screened stock pile which contained the bones of at least 2 animals, was derived from the deposit just above the lower Campbell beach.

BGS-840 Hubbell Creek II

uncorrected age: 9500 ± 120

The bison bone, sample 'Bone No. 2', was found in gravel-spit deposits in gravel pit F. The abraded bone, from the screened stock pile which contained the bones of at least 3 animals, was derived from the deposit just above the lower Campbell beach.

For comments, see BGS-617 (p. 130) in the section on paleontology.

Radiocarbon Dates related to the Moorhead Phase (Fig. 10c)

GSC-4732 Sprague

normalized age: 9940 ± 80
$\delta^{13}C$= -26.1‰
uncorrected age: 9920 ± 80

The wood (*Picea*; identified by H. Jetté (unpublished GSC Wood Report No. 88-36)) was enclosed in an organic layer and sand. The sample was collected by G. Matile on August 22, 1988, from 2.4 km east of Sprague on highway 12, southeast Manitoba (49°01'19"N, 95°36'35"W), at an elevation of 328 m. This sample was submitted by G. Matile to gain information on the lower Campbell level, Moorhead Phase, of Lake Agassiz.

Comment (G. Matile): This sample dates a Lake Agassiz shoreline, equal in elevation to the lower Campbell strandline, at the end of the Moorhead Phase of Lake Agassiz.

GSC-5697 Somme I

normalized age: 9950 ± 100
$\delta^{13}C$= -25.8‰
uncorrected age: 9970 ± 100

The wood (*Picea*; identified by H. Jetté (unpublished GSC Wood Report No. 94-63)) was enclosed in sand. Sample 'LM 537' from 1.7 m depth was collected by G. Matile on August 13, 1991, from 1 km southwest of Somme, southeast Manitoba (49°01'35"N, 96°20'13"W), at an elevation of 322 m. This sample was submitted by G. Matile to gain information on the Moorhead Phase of Lake Agassiz.

Comment (G. Matile): A backhoe test site was excavated on August 16, 1991. The sample was collected from below the watertable in unoxidized saturated sediment. The enclosing sediment contains abundant Paleozoic carbonate and disseminated organics which could contain pre-Quaternary organics such as lignite. The sediment enclosing and overlying the organics is believed to be a Moorhead Phase (Lake Agassiz) sequence, possibly a beach berm which has been subdued by Emerson Phase wave erosion.

GSC-5330 Somme II

normalized age: 9940 ± 90
$\delta^{13}C$= -26.7‰
uncorrected age: 9960 ± 90

The wood (*Picea*; identified by H. Jetté (unpublished GSC Wood Report No. 92-01)) was enclosed in glaciolacustrine sand of a beach berm. Sample 'LM-535' from 2.3 m depth was collected by G. Matile on August 12, 1991, from 1 km southwest of Somme, southeastern Manitoba (49°01'38"N, 96°20'13"W), at an elevation of 322 m. This sample was submitted by G. Matile to gain information on the Moorhead Phase of Lake Agassiz.

Comment (G. Matile): This sample dates a drowned beach berm of Lake Agassiz, from the end of the Moorhead Phase. This site is very similar in landform, strandline correlation, and age to GSC-4732 (above). Although it is similar in elevation to the lower Campbell strandline, it pre-dates it. The strandline which has been correlated with the lower Campbell in southeastern Manitoba has not been drowned.

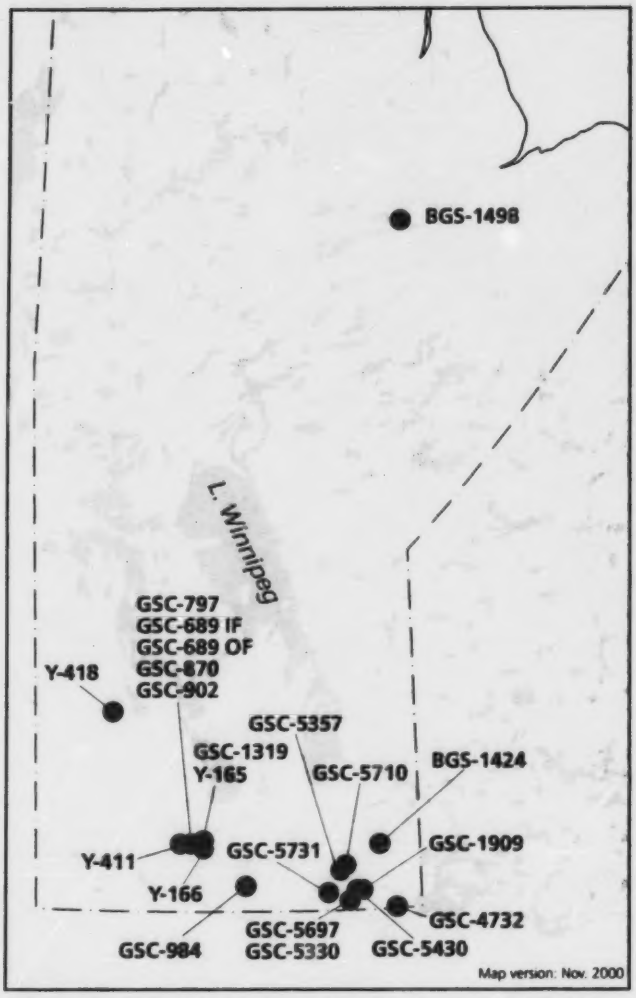

Figure 10c. Radiocarbon dates on the lake phases of Glacial Lake Agassiz: Moorhead Phase.

GSC-1909 Sundown I

uncorrected age: 10 200 ± 80

The organic material, vascular plants and moss, was enclosed in unoxidized fine sand and silt. Sample 'FW81-26-27' from 7.9-8.2 m in a borehole was collected by M.M. Fenton and J.T. Teller on July 9, 1972, from about 2.4 km east of Sundown, Manitoba (49°06'20"N, 96°14'15"W), at an elevation of about 326 m. This sample was submitted by M.M. Fenton to gain information on the initiation of the Moorhead Phase of Lake Agassiz.

Comments (M.M. Fenton): The sample provides a date for the fall of Glacial Lake Agassiz from the Campbell level at the start of the Moorhead Phase (Ashworth et al., 1972). It agrees with dates from the west side of the basin, e.g. GSC-902, 10.6 ka BP (Klassen and Elson, 1972) and from North Dakota - 10.9 (W-723) to 9.9 ka (W-993; both in Moran et al., 1973). The date also indicates that about 8 m of sediment were deposited during the succeeding high stand of the lake, which lasted about 500 years.

GSC-5430 Sundown II

normalized age: 10 200 ± 110
$\delta^{13}C$= -26.0‰
uncorrected age: 10 200 ± 110

The wood (*Picea*; identified by H. Jetté (unpublished GSC Wood Report No. 92-52)) was enclosed in sand. Sample 'L-003' from 2.5 m depth was collected by G. Matile and L.H. Thorleifson on August 13, 1991, from 2.5 km northwest of Sundown, Manitoba (49°06'51"N, 96°17'31"W), at an elevation of 322 m. This sample was submitted by G. Matile to gain information on the Moorhead Phase of Lake Agassiz.

Comment (G. Matile): A backhoe test site was excavated on August 13, 1991. The sample was collected from below the water table in unoxidized, saturated sediment. Pieces of wood were removed from the enclosing sediments after the sample was dry. The enclosing sediment contained abundant Paleozoic carbonate. Lignite was collected from enclosing material. The sediment enclosing and overlying the organics is interpreted to be an Emerson Phase (Lake Agassiz) sequence. The wood was abraded, which suggests that it was reworked 'Moorhead Phase' wood.

GSC-5731 Vita

normalized age: 9960 ± 190
$\delta^{13}C$= -25.1‰
uncorrected age: 9960 ± 190

The wood (*Picea*; identified by H. Jetté (unpublished GSC Wood Report No. 94-17)) was enclosed in silt and sand. The sample from 1.8 m depth was collected by G. Matile on August 8, 1991, from 3.5 km northeast of Vita, southeast Manitoba (49°09'48"N, 96°32'46"W), at an elevation of 303 m. This sample was submitted by G. Matile to gain information on the Moorhead Phase of Lake Agassiz.

Comment (G. Matile): A backhoe test pit was excavated on August, 8, 1991. A sample was collected from below the water table in unoxidized saturated sediment. The enclosing sediment contained abundant Paleozoic carbonate. There was some evidence of modern rootlets down to 2 m depth. Three samples were taken for ^{14}C dating; two containing pieces of wood from 1.8 m (GSC-5731) and 2.4 m (base of organics) and one containing fragments of several large bivalve molluscs. The sediment containing the organic material underlies and grades up into a suspected Emerson Phase (Lake Agassiz) sequence which has infilled a minor Moorhead Phase(?) channel. This wood sample from 1.8 m, is believed to be reworked from the basal organic mud unit and therefore dates the Moorhead Phase of Lake Agassiz.

GSC-984 Morden

uncorrected age: 5050 ± 180

The basal wood fragments were from the base of a 6.1 m-thick clay-rich silt and fine sand unit overlying lacustrine clay. Sample 'W-1-67' from 5.8 to 6.1 m depth was collected by J.E. Wyder in June, 1967, from 3.2 km east and 4 km north of Morden, Manitoba (49°15'N, 98°00'W), at an elevation of about 286 m. This sample was submitted by J.E. Wyder to gain information on the Moorhead? Phase of Lake Agassiz.

Comment (J.E. Wyder): The sample was dated to obtain the age between phases I and II of Lake Agassiz. The young date may represent, instead, the earliest flooding of Lake Agassiz plain by postglacial Red River.

GSC-5357 Zhoda

normalized age: 10 100 ± 90
$\delta^{13}C$= -28.0‰
uncorrected age: 10 200 ± 90

The wood (*Picea*; identified by H. Jetté (unpublished GSC Wood Report No. 92-05)) was enclosed in sand. Sample 'L021' from 2.5-3.5 m was collected by G. Matile on August 12, 1991, from 3.5 km southeast of Zhoda, southeastern Manitoba (49°17'41"N, 96°27'50"W), at an elevation of 311 m. This sample was submitted by G. Matile to gain information on the Moorhead Phase of Lake Agassiz.

Comment (G. Matile): The date confirms a Moorhead Phase origin for wood (flotsam). The enclosing sediment is believed to be littoral sand resulting from the formation of the landforms associated with the upper Campbell strandline, at the beginning of the Emerson Phase of Lake Agassiz.

GSC-5710 Marchand

normalized age: 10 100 ± 140
$\delta^{13}C$= -27.9‰
uncorrected age: 10 200 ± 140

The wood fragments (unidentifiable according to H. Jetté in an unpublished GSC Wood Report No. 94-69) were enclosed in sand. Sample 'LM 567' from 1.0-2.5 m depth was collected by G. Matile on August 16, 1991, from 6.5 km south of Marchand, southeast Manitoba (49°23'06"N, 96°23'50"W), at an elevation of 311 m. This sample was submitted by G. Matile to gain information on the Moorhead Phase of Lake Agassiz.

Comment (G. Matile): A backhoe test site was excavated on August 16, 1991 and the sample was collected near the watertable, consequently, the enclosing sediment is oxidized and wet. White mold was formed on wood fragments at time of collection. The enclosing sediment contains abundant Paleozoic carbonate. The sediment enclosing and overlying the organics is interpreted to be an Emerson Phase (Lake Agassiz) sequence, but the wood is believed to be reworked from the Moorhead Phase.

BGS-1424 Hadashville

uncorrected age: 7100 ± 400

The wood was enclosed in a fine gravel rich (70%) in Paleozoic carbonate clasts. Sample 'G 403 B' from depth of 2.3 m depth was collected by G. Matile on September 19, 1985, from 5 km south-southwest of Hadashville, Manitoba (49°37'24"N, 95°55'48"W), at an elevation of 308 m. This sample was submitted by G. Matile to gain information on the Moorhead or early Nipigon Phase of Lake Agassiz.

Local Stratigraphy: From the surface, black soil grades downward to fine sand at 1 m depth; overlies silt with rootlets from the surface and occasional shells near the base at 2 m depth; overlying fine pebble gravel with several twigs. Bottom of the hole was at 2.5 m.

Comment (G. Matile): The sample was collected from a backhoe test pit below the watertable at a depth of 2.3 m. The sample site is located on a Holocene fluvial terrace within an underfit channel, about 4 m above the present river. Based on the local height of land, water would need to be about 320 m asl to initiate a channel, i.e. Moorhead or early Nipigon Phase of Lake Agassiz.

Y-166 Assiniboine River terrace

uncorrected age: 11 230 ± 480

The freshwater pelecypod shells were enclosed in alluvium associated with Lake Agassiz. The sample from 4.6 m below the terrace was collected by J.A. Elson in 1952, from an Assiniboine River terrace, 9.6 km south and 3.6 km east of Rossendale, Manitoba (49°44'N, 98°34'W). This sample was submitted by J.A. Elson to gain information on the Moorhead Phase of Lake Agassiz, and the fluvial and deltaic processes.

Comments (by J.A. Elson): The dates for samples Y-165 (below) and -166 are considered to represent the time when a delta was built into Lake Agassiz.

Rossendale Series

A series of samples from about 6.5 km south of Rossendale, along highway 242 on the south side of the Assiniboine River valley, Manitoba (49°45'N, 98°39'W; GSC Locality No. O-107892; LSD9 sec. 17, pt.9 rge. 9, W1), at an elevation of 320 m, was collected by R.W. Klassen on July 14, and August 31, 1966, and May 22, and August 30, 1967. These samples were submitted by R.W. Klassen to gain information on the Moorhead Phase of Lake Agassiz and climate change to warmer.

GSC-797 Rossendale I

uncorrected age: 9700 ± 140

The wood sample 'KJ-6B-67' from about 5 m below the terrace was enclosed in alluvial and lacustrine silt and clay (clayey silt unit).

GSC-870 Rossendale II

uncorrected age: 10 000 ± 150

The wood, sample 'KJ-40-67' from 8.5 m below the terrace, at the base of a clay unit was above fluviolacustrine silt and sand, and was overlain by clay, silt and fluvial and eolian sand.

Comment (R.W. Klassen): Samples were taken from a fresh roadcut and adjacent gully exposing a total of about 20 m of sediment underlying an Assiniboine Valley terrace. The dates of this series record fluctuations in the level of Lake Agassiz subsequent to the initial drop in the level of Lake Agassiz I. Ostracodes and molluscs indicate that the dated unit was deposited in a slow-moving stream up to 10 m deep when the maximum air-temperature was 34°C. The level of Lake Agassiz was below 310 m at this time. A variety of plants (*Picea, Pinus, Betula, Artemisia* and *Myriophylum*) grew adjacent or in this stream (Klassen and Elson, 1972).

Consult GSC-689 below for general comments on the series.

GSC-902 Rossendale III

uncorrected age: 10 600 ± 150

The organic detritus, sample 'KJ-42-67', from 18 m below the terrace was enclosed in the lowest silty unit with organics of an alluvial and lacustrine silt-and-clay section.

Comment (R.W. Klassen): Samples were taken from a fresh roadcut and adjacent gully exposing a total of about 20 m of sediment underlying an Assiniboine Valley terrace. The dates of this series record the fluctuations in the level of Lake Agassiz subsequent to the initial drop in the level of Lake Agassiz I. Fossils indicate that the dated unit was deposited in slow-moving stream up to 1 m deep. The unit dates a low water phase of Lake Agassiz when the waterplane fell below 300 m and the climate became warmer (maximum air-temperature of 31°C) cf. Klassen and Elson, 1972.

GSC-689 OF Rossendale IV

uncorrected age: 10 720 ± 160

GSC-689 IF Rossendale V

uncorrected age: 10 920 ± 150

The freshwater pelecypod shells, sample 'FJ-43-66', from 1.5 to 4.5 m below the terrace were enclosed in alluvial and lacustrine silt and clay, and clayey silt. This was an old exposure of the same unit as GSC-797 (above).

Comment (R.W. Klassen): Alluvial and lacustrine silt and clay containing plant detritus and shells underlie an Assiniboine Valley terrace at about 320 m level. Samples were taken from a fresh roadcut and adjacent gully exposing a total of about 21 m of sediment underlying an Assiniboine Valley terrace. These dates on wood and plant detritus record fluctuations in the level of Lake Agassiz subsequent to the initial drop in the level of Lake Agassiz I. The dates on wood and plant detritus are internally consistent and indicate that shell dates are up to 1000 years too old. Younger terraces about 16 km up-valley and 21 m lower contain shells of similar age (GSC-492, 10 670 ± 160; cf. Emerson Phase of Lake Agassiz, above).

Y-411 Lavenham

uncorrected age: 10 550 ± 200

The wood was enclosed in sand overlying clayey sand and overlain by stratified sand and silt. Sample 'C-55-4' from 3.6-4 m depth was collected by J.A. Elson, A. Mozley and R.D. Bird in 1955, from Lonsbury Farm, 3.2 km south and 2 km west of Lavenham, Manitoba (49°46'N, 98°45'W), at an elevation of 320.1 m. This sample was submitted by J.A. Elson to gain information on the Moorhead Phase of Lake Agassiz, and the Valders advance.

Comment (J.A. Elson): The deposit is interpreted as alluvium, laid down in a ravine during the rising stage of Lake Agassiz II. This sample is 1.5 m (5 ft.) below GSC-383 (10 600 ± 150) and is reasonably consistent with that of sample Y-165 (below) as a date for Lake Agassiz II, confirming its correlation with the Valders advance.

GSC-1319 Rossendale

uncorrected age: 12 100 ± 160

The sandy peat (*Scorpidium scorpioides*; identified by M. Kuc) was in a spoil pile made during excavation of a reservoir in 1952. Sample

'F52-22(69)' was collected by J.A. Elson on August 14, 1969, from the east-west road allowance on the south side of a reservoir, 3.2 km south and 1.6 km east of Rossendale, Manitoba (49°46.8'N, 98°35.6'W), at an elevation of 320 ± 2 m. This sample was submitted by J.A. Elson to gain information on the Moorhead Phase of Lake Agassiz.

Lowdon, et al., 1971 (p. 282) provided an erroneous latitude of 49°47.0'N.

Comment (J.A. Elson): The site was sampled near the west end and 0.3 to 0.6 m below the surface on the crest of the spoil pile made during the excavation of a reservoir in 1952. This sample is duplicate of Y-165, 12 400 ± 420 (Preston et al., 1955), collected by Elson and is considered too old. The peat on the spoil pile was from the bottom of the reservoir which was about 4 m deep, already filled with water when first visited, a few days after completion. An auger hole just west of the reservoir penetrated about 1.5 m sandy and silty alluvium, overlying about 2 m clay with fragments of wood, charcoal, and snail shells near the base, 0.6 m sandy clay, and 0.2 m fine brown sand similar to that associated with peat on spoil pile; an ingress of water prevented further boring. The peat was typical of subarctic and northern parts of the Boreal Forest and grows in shallow, trophic, still, rather small ponds surrounded by bogs or fens, but not by forest (M. Kuc, written communication). The peat accumulated in a gully formed in Assiniboine delta during an early low-water phase of Lake Agassiz (Elson, 1967). The gully was subsequently submerged during a higher stand of the lake, possibly at Norcross strandline, and was exposed again as lake receded. The upper part of the gully system was later captured by a small tributary of the Assiniboine River and the lower part was blocked by sand dunes that formed along Campbell strandline. The date confirms Y-165 and supports the concept of an early extensive phase of Lake Agassiz while stagnant ice existed on plains to the west and south.

Consult GSC-4490, (above, p. 117) in the section on the 'Emerson Phase', for additional comments.

Y-165 Rossendale II

uncorrected age: 12 400 ± 420

The peat was enclosed in peat and buried under 4 m of alluvium associated with Lake Agassiz. The sample was collected by J.A. Elson in 1952, from a reservoir in a gully, 4.8 km south and 1.6 km east of Rossendale, Manitoba (49°47'N, 98°35'W), at an elevation of 320.7 ± 1.5 m. This sample was submitted by J.A. Elson to gain information on the Moorhead Phase of Lake Agassiz.

Consult GSC-1319 above for comments.

Y-418 Ashville

uncorrected age: 1400 ± 80

The basal peat was enclosed in a 10 cm-thick peat layer overlying stony clay. Sample 'C-55-14' was collected by J.A. Elson in 1955, from a lagoon behind a beach ridge of Lake Agassiz, 8 km south of Ashville, Manitoba (51°10'N, 100°15'W), at an elevation of 384 m. This sample was submitted by J.A. Elson to gain information on the Moorhead? Phase of Lake Agassiz.

Comment (J.A. Elson): The bog is believed to postdate Lake Agassiz I because of its altitude (above the highest level of Lake Agassiz II). Contamination by rootlets is a distinct possibility.

BGS-1498 Stephen's Lake

uncorrected age: 3950 ± 100

The charcoal (organic material) was enclosed in about 10 cm-thick bed of organics over 1 m silty clay and under 0.5 m Agassiz clay. Sample 'Stephen's Lake 91-1' from 50 cm depth was collected by E. Nielsen on September 9, 1991, from a gravel pit along highway on north side of Stephen's Lake, 200 km northeast of Thompson, Manitoba (56°34'N, 95°20'W), at an elevation of about 150 m. This sample was submitted by E. Nielsen to gain information on the Moorhead? Phase of Lake Agassiz.

Comment (E. Nielsen): The sample was dated to provide information on the early regression of Lake Agassiz from the area. The young date suggests that the sample may have been incorporated in the sediment by cryoturbation or slumping.

Radiocarbon Dates related to the Lockhart Phase (Fig. 10d)

GSC-1369 Thornhill Terrace

uncorrected age: 14 300 ± 320

The organic detritus was enclosed in fluviolacustrine deposits. Sample '19-106-69' from 323.0-325.8 cm depth was collected by L.D. Delorme in July, 1969, from Thornhill Terrace, 2.4 km north of Thornhill and 8 km west of Morden, Manitoba (49°13.7'N, 98°13.6'W), at an elevation of about 375 m. This sample was submitted by L.D. Delorme to gain information on the Herman level, Lockhart Phase, of Lake Agassiz, and to provide a paleoenvironmental assessment.

Comment (L.D. Delorme): Analysis of the shelled invertebrates from the lowermost organic-rich layer indicates a shallow water, intermittent stream draining the forested uplands into Lake Agassiz. The elevation corresponds to the earliest Herman beach of Lake Agassiz (see Klassen, 1975; Teller, 1976).

Comment (W. Blake, Jr.): This date was published with an incorrect error term of '± 1970' years by Klassen (1972; 1975). Teller (1976, p. 39) believed that the lake sediments from which this sample was obtained "may only be related to local ponding between the Manitoba Escarpment and the active ice to the east", and he suggested that "widespread ponding in the Lake Agassiz basin did not occur until after 14 ka BP".

Refer to GSC-1349 (above, p.116) for a description of the series.

Y-416 Stockton

uncorrected age: 8020 ± 100

The peat with wood fragments was overlying sand and gravel over till, and overlain by sand with paleosol horizons. Sample 'C-55-11' was collected by J.A. Elson in 1955, from 3.0 km north and 5.5 km

east of Stockton, on the north bank of the Assiniboine River, Manitoba (49°37'N, 99°22'W), at an elevation of 337 m. This sample was submitted by J.A. Elson to gain information on the Lockhart Phase of Lake Agassiz, and geomorphic deltaic processes.

Comment (J.A. Elson): The dated, 1.2 m-peat bed, was underlain by till and by 5 m of sand and gravel, and overlain by 7.6 m of sand containing fossil soil horizons. The sand enclosing the peat bed is interpreted as part of the Assiniboine Delta laid down in Lake Agassiz I and should be about contemporary with sample Y-415.

Y-415 Treesbank

uncorrected age: 9110 ± 110

The basal wood was enclosed in silty sand overlying sand and gravel over till, and overlain by 4.6 m of silty sand. Sample 'C-55-13a' was collected by J.A. Elson, S. Criddle and R.D. Bird in 1955, from 3.2 km north and 3.2 km east of Treesbank, on the north bank of the Assiniboine River, about 1.6 km (1 mi.) east of the mouth of the Souris River, Manitoba (49°39'50"N, 99°33'20"W), at an elevation of 335.5 to 343 m. This sample was submitted by J.A. Elson to gain information on the Lockhart Phase of Lake Agassiz, and geomorphic deltaic processes.

Comment (J.A. Elson): The enclosing material, a 4.6 m (15-ft) layer of silty sand, was underlain by till and by 2.4 to 3.0 m (8-10 ft) of gravel and sand deposited on eroded surface of till. The sample was overlain by about 7.6 m (25 ft) of sand containing a fossil soil horizon and was eolian at the surface. The wood-bearing sand is tentatively interpreted as part of the Assiniboine Delta laid down in Lake Agassiz I.

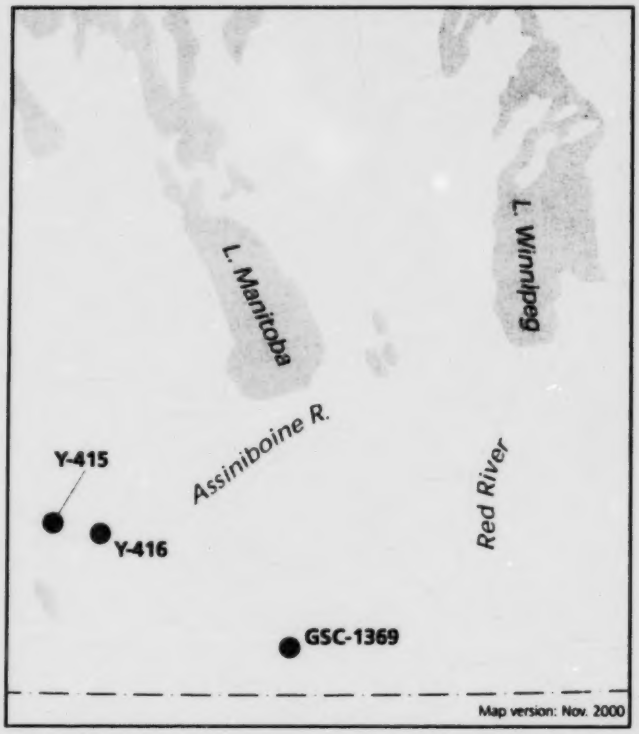

Figure 10d. Radiocarbon dates on the lake phases of Glacial Lake Agassiz: Lockhart Phase.

PRE-HOLOCENE RADIOCARBON DATES IN MANITOBA (Fig. 11)

GX-3527 Vita

uncorrected age: >32 000

The charcoal was enclosed in silty sand that grades downward into gravel and is overlain by Roseau till. The sample from 7 m depth in an auger hole was collected by J.T. Teller in 1971, from 5 km southwest of Vita, Manitoba (49°07'N, 96°38'W). This sample was submitted by J.T. Teller to gain information on the late Wisconsin.

Comment (J. Teller): The sample was from a depth of 7 m near top of a 20 m-thick silty sand that grades downward into gravel. The unit was overlain by Roseau till of late Wisconsinan age. The dated unit has a 'salt and pepper' appearance due to organic fragments. Some of these fragments are hard and may be coal or black shale. The date is suspected as being too old because of contamination.

GSC-4760 Stuartburn

normalized age: 35 500 ± 870
$\delta^{13}C$= -26.4‰
uncorrected age: 35 500 ± 870

The coniferous wood (identified by R.J. Mott (unpublished GSC Wood Report No. 88-40)) fragments were enclosed in sand. Sample 'G586' was collected by G. Matile and H. Groom on September 9, 1988, from 3 km northeast of Stuartburn, southeastern Manitoba (49°09'45"N, 96°43'03"W), at an elevation of 291 m. This sample was submitted by G. Matile to gain information on the pre-Holocene deposit.

Comment (G. Matile): The stratigraphic position suggests a late glacial age. However, the sample contains microfossils (including amber, lignite and seed cases) of Late Cretaceous and Palaeocene age (Report 3-DHM-1989, Institute of Sedimentary and Petroleum Geology) which accounts for the anomalously old date. It is one of the numerous samples from a similar stratigraphic position, which are contaminated by Cretaceous carbon, cf. BGS-625 (29 100 ± 1100 BP), and BGS-635 (29 600 ± 900 BP) below, and BGS-727 (31 000 ± 1000 BP) in the section on 'Peat'.

Roseau River Series

A series of samples from 13 km east of the town of Roseau River, Manitoba (49°11'N, 96°39'W; LS7, Sec.1, T.3, R.6E), at an elevation of 289.6 m, was collected by J.T. Teller and M.M. Fenton in 1973. These samples were submitted by J.T. Teller to gain information on the sub-till pre-Holocene deposits.

GX-3531 Roseau River I

uncorrected age: >39 000

The wood and organic detritus sample from 29.5-29.6 m depth in an auger hole was enclosed in silty clay to silty sand overlain by the Whitemouth Lake and Marchand tills.

Comment (J. Teller): The zone in which the sample was enclosed, was overlain by laminated clayey silt and was contained within a 25 m unit of silty clay to silty sand with numerous concentrations of finely disseminated organic matter. This date comes from what seems to be the same lacustrine unit as GX-3530, but 9 m below it. GX-3530 is interpreted as being deposited in a proglacial (late Wisconsinan) lake. Because of the more than 17 ka difference in age between these two dates it seems that either GX-3531 is contaminated by old carbon or that there is a stratigraphic unconformity between the two.

GX-3530 Roseau River II

uncorrected age: 22 260 +1000 -900

The wood and organic detritus sample from a depth of 20.4 m in an auger hole was enclosed in organic-rich basal silt overlain by the Whitemouth Lake and Marchand tills.

Comment (J. Teller): The sample from depth of 20.4 m near organic-rich basal part of 8.5 m-thick silt, was overlain by the Whitemouth Lake and Marchand tills. The sample was enclosed in a 25 m unit of silty clay to silty sand with numerous concentrations of finely disseminated organic matter. This date is thought to reflect the age of proglacial lacustrine deposits as late Wisconsinan ice impounded water in the Lake Agassiz basin.

GSC-1465 Roseau River

uncorrected age: >38 000

The organic material was enclosed in a 4 cm-thick discontinuous sand layer between Stuartburn and Woodmore tills. Sample 'FW-S14-10' was collected by M.M. Fenton on September 6, 1970, from about 0.2 km east of section road, on the south side of Roseau River, Manitoba (49°11'05"N, 96°53'35"W), at an elevation of 262 m. This sample was submitted by M.M. Fenton to gain information on the early Wisconsin or pre- Wisconsin.

Comment (M.M. Fenton): The date provides the first proof of mid-Wisconsin or older units in southeastern Manitoba. The date GSC-1663 (>41 ka on wood, Lowdon and Blake, 1976) was from material overlying the Stuartburn Till (Fenton, 1974), suggesting that GSC-1465 is either early Wisconsin or pre- Wisconsin in age.

GSC-1801 Roseau River

uncorrected age: >43 000

The wood (*Picea*; identified by L.D. Wilson (unpublished GSC Wood Report No. 72-56)) was enclosed in a 5 m-thick fine sand underlying the Senkiw Till and overlying Stuartburn Till. Sample 'FWS35-U5' was collected by M.M. Fenton on August 16, 1972, from about 2.4 km west of the settlement of Roseau River, Manitoba (49°11'12"N, 96°51'45"W), at an elevation of about 267 m. This sample was submitted by M.M. Fenton to gain information on the mid-Wisconsin.

Comment (M.M. Fenton): The date is similar to GSC-1663 (>41ka, on wood, Lowdon and Blake, 1976) collected in a similar stratigraphic position about 4.5 km to the west along the river. The sample provides a minimum age for the enclosing sediment which is believed to be mid-Wisconsin in age.

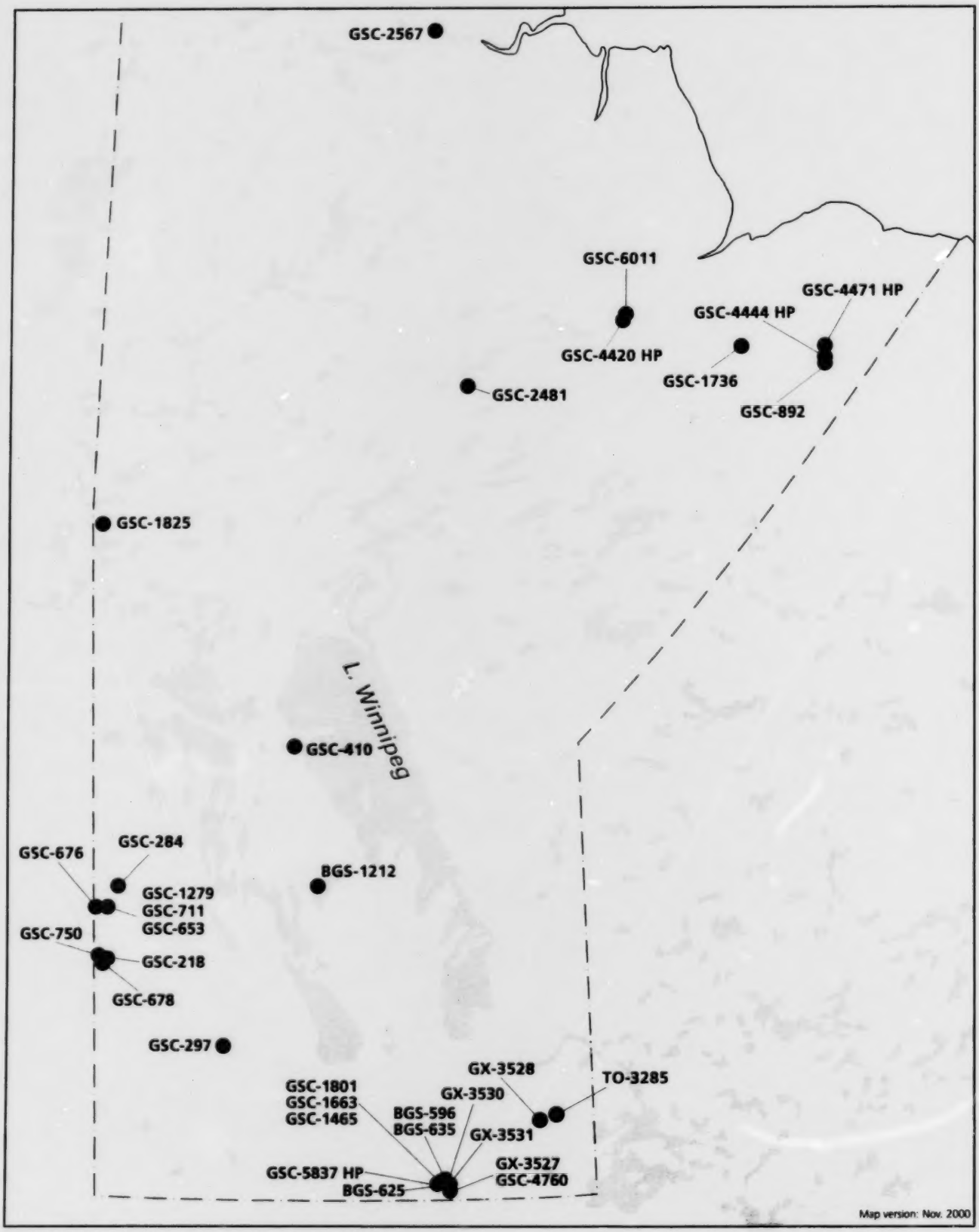

Figure 11. Radiocarbon dates on materials of pre-Holocene age

GSC-1663 Senkiw

uncorrected age: >41 000

The wood (*Picea*; identified by R.J. Mott (unpublished GSC Wood Report No. 72-01)) was found 60 cm into a wet unoxidized silt exposed by a recent slump. Sample 'FWS-21-U6' from 5 m depth was collected by M.M. Fenton on August 21, 1971, from the south side of Roseau River, about 3.5 km west of Senkiw post office, Manitoba (49°11'30"N, 96°55'10"W), at an elevation of about 262 m. This sample was submitted by M.M. Fenton to gain information on pre-Holocene deposits.

Comment (M.M. Fenton): The wood was in silt 3 m below the Roseau Till and overlying the Stuartburn Till (Fenton, 1974); the age is in agreement with GSC-1801 (>43 ka, on wood, Lowdon and Blake, 1976) collected from a similar stratigraphic position about 4.5 km east along the river. The wood-bearing unit is believed to be of mid-Wisconsin age.

BGS-625 Roseau River

uncorrected age: 29 500 ± 1100

The organic material was enclosed in silt. Sample 'Roseau River 38' was collected by S. Ringrose on October 3, 1979, from a river cliff on the Roseau River, southern Manitoba (49°11'45"N, 96°52'30"W). This sample was submitted by S. Ringrose to gain information on the early Wisconsin.

The samples were collected from a river cliff, in a fresh, dry exposure with no associated plant growth. The section was comprised from base upwards of blue grey silty sand / till / carbonaceous silt / fine sand and silt / coarse gravel / sand 'loess'. The sample from a spruce log was dated to see if there is a possible correlation with the Mid-Wisconsin Zelena Formation (Fenton, 1974). Other beds have been dated yielding nonfinite radiocarbon ages of >43 ka (GSC-1801) and >41 ka BP (GSC-1663) and are of probable Early Wisconsin age.

Comments (S. Ringrose): Material was obtained from Fenton's (1974, p. 246) Vita Formation believed to be underlain by the Tolstoi and Stuartburn tills. Previous nonfinite dates for the Vita Formation suggested that it was of Sangamon or Early Wisconsin age. This finite age makes the Vita Formation the lateral equivalent of the Zelena Formation (GSC-653, 37.7 ka, Klassen, 1969, p. 5), hence Fenton's (1974) uppermost tills, mainly the Senkiw Till and Roseau Till can both be attributed to the 'Classical' Wisconsin glaciation.

GSC-5837 HP Senkiw

uncorrected age: >49 000

The wood (*Picea*; identified by H. Jetté (unpublished GSC Wood Report No. 94-87)) was a surface collection on riverbank silt / diamicton. Sample '91 TCA 282.9 Grape Section' was collected by G. Matile and L.H. Thorleifson on August 27, 1991, from 4.5 km west of Senkiw, on the Roseau River, southeast Manitoba (49°11'54"N, 96°54'09"W), at an elevation of 259 m. This sample was submitted by L.H. Thorleifson to gain information on the Wisconsin deposits.

Comment (G.L.D. Matile): The sample was collected from the surface of a natural river bank, 10.5 m below prairie level. Enclosing sediment had been 'baked' by the sun. The Big Bend Section, 0.5 km west of the Grape Section, was described by Fenton (1974). Preliminary correlation suggests that these two sections are stratigraphic equivalents. The upper sand unit is correlated with the Upper Hazel Formation and the diamicton unit is correlated with the Senkiw Formation. Sub-Senkiw Formation ^{14}C dates from southeast Manitoba and vicinity range from 32.8 to >43 ka BP. This is the first time that wood has been collected from the Senkiw Formation.

BGS-596 Rosa

uncorrected age: >50 000

The wood (not identified) was enclosed in 1 m of till / 4 m sand and gravel / 0.5 m till with wood / oxidized sand. Sample 'GM 140 (B)' was collected by G. Matile on October 31, 1978, from a gravel pit, 40 km east-southeast of Morris near Rosa, highway 59, Manitoba (49°15'05"N, 96°49'55"W), at an elevation of 278 m. This sample was submitted by G. Matile to gain information on the pre-Holocene deposits.

Comments (G. Matile): The upper till is correlated with Roseau Till and lower till with Tolstoi Till of Fenton (1974).

BGS-635 Barkfield

uncorrected age: 29 600 ± 900

The charcoal mixed with wood fragments was enclosed in silt and fine sand underlying till (Steinbach Till) and overlying sand. Sample 'GB 161' was collected by G. Matile on December 3, 1979, from southeast of Barkfield, about 25 km from Steinbach, southeastern Manitoba (49°18'13"N, 96°45'30"W), at an elevation of 280 m. This sample was submitted by G. Matile to gain information on the pre-Holocene, sub-till deposits.

Comment (G. Matile): The sample was collected from a 4 m-deep backhoe pit, which was situated in the bottom of a 1 m ditch. The enclosing material was wet and unoxidized. The overlying till is correlated with the Steinbach Till described by Fenton (1974). The underlying sand may be correlated with early Lake Agassiz and if so, is probably 12 to 14 ka old.

GX-3528 Marchand

uncorrected age: >30 000

The wood and organic detritus was enclosed in sand to sandy silt containing some pebbles. The sample from 32 m depth was collected by J.T. Teller in 1973, from 17 km east of Marchand on Sandilands ridge, Manitoba (49°28'N, 96°08'W), at an elevation of 341.5 m. The sample was submitted by J.T. Teller to gain information on the pre-Holocene deposits.

Comment (J. Teller): An auger hole with 48 m of sand to sandy silt containing some pebbles was drilled. The wood was from a 3 m zone with black laminae containing finely disseminated organic matter. This date is surprisingly old and may have been contaminated by coal.

TO-3285 McMunn

normalized age: 43 730 ± 750

The organic sediment was enclosed in sand. Sample '92-TCA-A' from 12.0-14.0 m depth was collected by G. Matile and L.H. Thorleifson on February 25, 1992, about 9 km south-southwest of McMunn, and about 75 km southeast of Beausejour,

southeastern Manitoba (49°33'24"N, 95°45'08"W), at an elevation of 330 m. This sample was submitted by G. Matile to gain information on the late Wisconsinan.

Comment (L.H. Thorleifson): The sequence consists of 0-4.9 m sand and gravel, 4.9-6.8 m silty till, 6.8-19.3 m silt and sand, 19.3-26.2 m sandy till, 26.2 m bedrock. The date on disseminated organic material in sand between 12 and 14 m depth indicates that the upper till is the late Wisconsinan, or that the entire sequence is late Wisconsinan and that older organic material was reworked during subglacial and/or ice marginal glaciofluvial sedimentation. The possibility of a late glacial readvance overriding post-late-Wisconsinan organic material is not supported.

GSC-297 Minnedosa River valley

uncorrected age: >31 300

The organic material (grass) was enclosed in inter-till silt overlain by three tills separated by stratified sediments. Sample 'KJ-52-64' was collected by R.W. Klassen on June 27, 1964, from 26 m-high road cut along Minnedosa River valley, Manitoba (50°22'N, 99°56'W). This sample was submitted by R.W. Klassen to gain information on the pre-Holocene deposit.

Comment (R.W. Klassen): The close resemblance of the enclosed bones to those of Arctic ground squirrel (*Spermophilus parryii*; formerly *Citellus undulatus*) and tundra vole (*Microtus oeconomus*) suggest that the silt is an interstadial deposit.

GSC-678 Shellmouth

uncorrected age: >41 000

The wood was enclosed in alluvial sand beneath drift (61-76 m including at least 3 tills) and overlying bedrock. Sample 'KJ-15-66' was collected by R.W. Klassen on June 8, 1966, from the damsite excavation at base of east wall of Assiniboine River valley, 6 km northeast of Shellmouth, Manitoba (50°58'N, 101°24'W). This sample was submitted by R.W. Klassen to gain information on the pre-Holocene deposits.

Comment (R.W. Klassen): The sand containing wood on which date GSC-678 was obtained is interpreted as an interglacial deposit within the preglacial valley, here crossed by Assiniboine River valley. This date was erroneously reported as >42 600 in Klassen (1967b).

GSC-218 Inlis

uncorrected age: >30 000

The wood fragments were enclosed in clay overlain by two tills and underlain by silt over shale. Sample 'KJ-T.H. 44-63' from 60-65 m depth in a borehole was collected by R.W. Klassen on August 29, 1963, from Riding Mountain, about 3 km northeast of Inlis, Manitoba (50°59'N, 101°10'W). This sample was submitted by R.W. Klassen to gain information on the pre-Holocene deposits.

Comment (R.W. Klassen): The silt may correlate with a stratified layer overlying a third till encountered in several other boreholes on the southwest slope of Riding Mountain Upland (Tp. 18, Rge. 20).

GSC-750 Dropmore

uncorrected age: >42 000

The wood was enclosed in sand and gravel underlying at least 3 tills. Sample 'KJ-47-66' from 74 to 100 m depth was collected by R.W. Klassen on August 9, 1966, from about 1 km south of Dropmore, Manitoba (51°01'N, 101°27'W). This sample was submitted by R.W. Klassen to gain information on the pre-Holocene or interglacial deposits.

Comment (R.W. Klassen): The sand and gravel may be the subsurface equivalent of the exposed unit from which GSC-678 (above) was taken.

GSC-676 Makaroff

uncorrected age: >34 000

The wood fragments were enclosed in the upper surface of varved clay and basal zone of overlying till. Sample 'KJ-13-66' was collected by R.W. Klassen on June 5, 1966, from about 1.6 km east and 3 km north of Makaroff, Manitoba (51°23'N, 101°29'W). This sample was submitted by R.W. Klassen to gain information on the pre-Holocene deposits.

Comment (R.W. Klassen): The varved clay, up to 1.3 m-thick, was underlain by stony silt and overlain by two tills. The date records a nonglacial interval preceding at least two glaciations in this region. The date was originally reported as >42 600 (Klassen, 1967b), but was subsequently revised by the GSC Laboratory.

Shell River valley Series

A series of samples from a roadcut on the east side of the Shell River valley, about 1.6 km north and 5 km east of Zelena, Manitoba (51°24'N, 101°14'W; NW 1/4 sec. 17, pt. 28, rge. 27, W 1st mer.), was collected by R.W. Klassen on June 30, 1966 and June 15, 1969. These samples were submitted by R.W. Klassen to gain information on the pre-Holocene or interstadial deposits.

GSC-1279 Shell River valley I

uncorrected age: 23 700 ± 290

The charred material, charcoal sample 'KJ-10-69', was enclosed in a 1 m-thick lacustrine silt and marl separating surface till from underlying till.

Stratigraphy:
The deposits from the top down were gravel / Lennard Till / silt (dated), marl, and clay / Minnedosa Till / Shell Till.

Comment (R.W. Klassen): The date is considerably younger than previous dates on charcoal (GSC-653, 37.7 ka) and marl (GSC-711, 28.2 ka BP; Lowdon and Blake, 1968, p. 217) from the same units (see below). As suggested earlier, the oldest date is considered most reliable, but additional dates are required to establish the age range in these interstadial deposits.

GSC-711 Shell River valley II

uncorrected age: 28 220 ± 380

The marl sample 'KJ-5-66' from 4.6 m below surface was enclosed in marl underlying silt. The marl was composed almost entirely of calcium carbonate.

Stratigraphy:
gravel / Lennard Till / marl (dated), silt, and clay / Minnedosa Till / Shell Till.

Comment (L.D. Delorme): Ostracodes from the highly fossiliferous marl bed, in part overlying or interbedded with the previously dated silt (GSC-653), indicate that it was deposited in a mesotrophic or eutrophic lake similar to the present-day lakes in this area.

Comment (R.W. Klassen): The apparent age difference between the sample and the associated date is probably due to contamination of the marl by modern carbon.

GSC-653 Shell River valley III

uncorrected age: 37 700 ± 1500

The charred material, charcoal sample 'KJ-7-66', from 3-4.6 m depth was enclosed in lacustrine silt above a marl zone.

Comment (R.W. Klassen): The Zelena series includes samples of lacustrine silt and marl that separate the surface till from an underlying till. Organic remains in the silt bed in the Zelena section indicate an interval of at least interstadial rank following the deposition of (early Wisconsinan) Minnedosa Till.

General comments on series (R.W. Klassen): The apparent age difference of charcoal and marl is probably due to contamination of marl by modern carbon. The more reliable charcoal date suggests a maximum age for the silt. Inter-till beds can probably be correlated with deposits of the redefined Port Talbot Interstade in Lake Erie region (Klassen, 1967a; Dreimanis et al., 1966).

BGS-1212 Gypsumville

uncorrected age: 4870 ± 90

The organic silt was enclosed in calcareous, gypsumiferous silt. Sample 'Gypsumville #1' was collected by E. Nielsen in June, 1987, from a gypsum quarry at Gypsumville, Manitoba (51°48'N, 98°38'W). This sample was submitted by E. Nielsen to gain information on the late Wisconsin.

GSC-284 Roaring River

uncorrected age: >37 760

The organic detritus was enclosed in fossiliferous silt overlain by two tills and underlain by sand and gravel. Sample 'KJ-2-64' from 22 m depth was collected by R.W. Klassen on June 4, 1964, from along Roaring River, Duck Mountain, Manitoba (51°51'N, 101°08'W). This sample was submitted by R.W. Klassen to gain information on the pre-Holocene or interstadial deposits.

Comment (R.W. Klassen): Studies of ostracodes and molluscs from the silt suggest an interstadial climate, rather than an interglacial one as suggested by Tyrrell (1892, p. 217 E).

GSC-410 Grand Rapids

uncorrected age: 4670 ± 130

The basal peat was overlying a coarse lag gravel and overlain by 1.5 m of peat. Sample 'KJ-1-65' from 152 cm depth was collected by R.W. Klassen on June 9, 1965, from about 29 km south of Grand Rapids along highway 6, near the crest of The Pas Moraine, Manitoba (52°53'N, 99°08'W). This sample was submitted by R.W. Klassen to gain information on deglaciation, and provide a minimum age for the moraine.

Comment (R.W. Klassen): The sample was dated in an attempt to obtain a minimum age for the moraine, but the date is believed to be considerably younger than the age of the moraine. Consult S-2473 (p. 41) on peat for additional comments.

Note: Zoltai et al., 1988 gave coordinates as 53°59'N and 101°12'W.

GSC-1825 Flin Flon

normalized age: 7970 ± 150
$\delta^{13}C$= -31.8‰
uncorrected age: 8080 ± 150

The basal gyttja lake sediment was enclosed in basal, clayey, laminated gyttja. Sample 'MS-72-4' from 371-376 cm depth was collected by R.J. Mott on July 1, 1972, from a small unnamed lake in a bedrock basin beside highway 10, 11.2 km east-southeast of Flin Flon, northern Manitoba (54°44'30"N, 101°40'43"W), at an elevation of about 305 m. This sample was submitted by R.J. Mott to provide a minimum age for deglaciation.

Comments (R.J. Mott): This lake is probably above the limit of Glacial Lake Agassiz in the area, and therefore the date should be a minimum for deglaciation of the area. The date is somewhat younger than expected, however, and more detailed work is needed to determine the postglacial history of the area (Mott, 1973). As the $\delta^{13}C$ determination was not available in time, the date reported by Mott (1973) as 8080 ± 150 was the uncorrected value.

GSC-892 Echoing River

uncorrected age: >37 000

The wood was enclosed in laminated organic-rich silt overlying 7.5 cm of peat and overlain by 5.5 m of till. Sample 'CD 123-3/67' was collected by B.G. Craig on August 12, 1967, from bank of unnamed tributary of Echoing River, 35.8 km north-northeast of confluence of Echoing and Sturgeon Rivers, Manitoba (55°50'30"N, 91°15'W), at an elevation of about 122 m. This sample was submitted by B.G. Craig to gain information on the pre-Holocene, or interglacial deposits.

Comment (B.G. Craig): The wood is probably part of a widely exposed unit in Hudson Bay Lowland that has been interpreted as being of interglacial age; cf. GSC-1011 (>41 000, in Lowdon and Blake, 1970), GSC-83 (>35 000; in Dyck and Fyles, 1963; McDonald, 1969).

GSC-2481 Fox and Stupart Rivers

uncorrected age: >37 000

The wood (*Picea*; identified by L.D. Farley-Gill (unpublished GSC Wood Report No. 77-17)) was enclosed in diamicton (till) overlain by gravel and till, and underlain by gravel. Sample '56-76-3' was collected by J. Clue on July 7, 1976, from the junction of Fox and Stupart Rivers, Manitoba (55°52.2'N, 96°19.8'W), at an elevation of about 100 m. This sample was submitted by L.A. Dredge to gain information on the mid-Wisconsin or older deposits.

Comments (L.A. Dredge): The wood was taken from the lower of two tills which are separated by a gravel bed in a 11 m-high section. The sampled unit also is underlain by gravel. The date suggests that the lower till at this site is probably mid-Wisconsin or older.

GSC-4444 HP Echoing River

uncorrected age: >51 000

The wood (*Picea*; identified by R.J. Mott (unpublished GSC Wood Report No. 85-7)) was enclosed in peat. Sample 'DU-84-115' was collected by L.A. Dredge and E. Nielsen on June 17, 1984, from 6 km above the confluence, on the right bank of a creek emptying into Echoing River, Manitoba (55°55.1'N, 91°15.0'W), at an elevation of 120 m. This sample was submitted by L.A. Dredge to gain information on the pre-Holocene, or interglacial deposits.

Comment (L.A. Dredge): The wood and peat were located near the top of a thick sequence of sub-till marl, peat, and lacustrine sediments with temperate climate flora and fauna. They are therefore thought to be deposits of the Sangamon Interglaciation (Dredge, et al., 1990).

GSC-1736 Gods River

uncorrected age: >41 000

The wood (*Picea*; identified by R.J. Mott (unpublished GSC Wood Report No. 72-23)) was at the contact of a silty peat bed underlain by till and overlain by two tills. Sample 'KJ-57-72' was collected by J.A. Netterville on June 24, 1972, from along Gods River in the Hudson Bay Lowlands, northeastern Manitoba (56°09'N, 92°31'W), at an elevation of about 43 m. This sample was submitted by R.W. Klassen to gain information on the pre-Holocene deposits.

Comment (R.W. Klassen): The date and the stratigraphy suggest that the peat bed correlates with the Missinaibi peat beds of the southern Hudson Bay Lowlands (Klassen and Netterville, 1973; cf. Terasmae and Hughes, 1960). M. Kuc reports (unpublished GSC Bryological Report No. 185) that the mosses in the peat are a mixture of hydrophytes and xerophytes.

GSC-4471 HP Twin Creeks

uncorrected age: >49 000
$\delta^{13}C$= -26.1‰

The wood (*Picea*; identified by R.J. Mott (unpublished GSC Wood Report No. 85-5)) was enclosed in sandy detritus underlying till. Sample 'DU-84-117' was collected by L.A. Dredge and E. Nielsen on June 17, 1984, from the right bank of Gods River, near Twin Creeks, Manitoba (56°9.5'N, 91°15.0'W), at an elevation of about 80 m. This sample was submitted by L.A. Dredge to gain information on the nonglacial deposits of early Wisconsin or more likely a Sangamon age.

Comment (L.A. Dredge): The wood was collected from beds of sandy detritus underlying till, and is thought to be of Sangamonian age (Dredge, et al., 1990). Also see GSC-4420 HP for comments.

GSC-4420 HP Limestone Dam

uncorrected age: >49 000
$\delta^{13}C$= -24.5‰

The wood (*Picea*; identified by R.J. Mott (unpublished GSC Wood Report No. 87-14)) was enclosed in sand. Sample 'Henday Section' was collected by E. Nielsen and R.N.W. DiLabio on June 30, 1986, from about 2 km southwest of the new Limestone Dam on the north side of Nelson River, Manitoba (56°29'N, 94°07'W), at an elevation of 90 m. This sample was submitted by E. Nielsen to gain information on the nonglacial of the early Wisconsin or more likely Sangamon age.

Comment (E. Nielsen): This date (see also GSC-4471 HP, above) is on wood from a major nonglacial interval recorded at numerous sites in northeastern Manitoba. This interval, variously represented by the Gods River and Nelson River sediments, is correlated with the Missinaibi Formation in Ontario, based on pollen content and on aspartic acid ratios on wood. The date indicates these sediments are not of Middle Wisconsinan age and further suggests an Early Wisconsinan or more likely a Sangamon age. "Radiocarbon and Th/U dating on wood, aspartic acid D/L determinations on wood, and paleoentomological, and paleomagnetic studies have been undertaken at this site, but with inconclusive results (discussed by Nielsen et al., 1986, 1988). Recent high-pressure ^{14}C dating indicates that wood recovered from the peaty layers is >49 000 BP (GSC-4420, CO_2 extracted from 4 times the usual sample size, counted for 3 days in a 5 L counter at 4 atm (1 atm = 101 kPa) pressure; Nielsen et al., 1988), thus apparently excluding the possibility of a Middle Wisconsinan age. However, it is unclear whether the alpha-cellulose fraction of the wood was dated. We think that either this wood is reworked (unlikely) or that the ^{14}C result is inaccurate. The paleoentomological studies of the peat indicate deposition in a small, quiet-water tundra lake or backwater fluvial environment close to, but north of the tree line under conditions slightly colder than at present, more like an interstade than an interglaciation (Nielsen et al., 1986). On the other hand, the pollen spectra are similar to those described for the interglacial Missinaibi Formation by Terasmae (1958) and for other sediments having 'nonfinite' (>40-50 ka) ^{14}C ages (Dredge et al., 1990)." Berger and Nielsen, 1991.

GSC-6011 Limestone Dam

uncorrected age: >37 000
$\delta^{13}C$= -26.32‰

The wood was enclosed in slightly deformed peat capping oxidized fluvial sand and gravel, overlain by clay. Sample '95 MOON 008' was collected by M. Roy on June 19, 1995, from the south shore of the Nelson River, near the Limestone Dam, 50 km northeast of Gillam, Hudson Bay Lowlands, northeastern Manitoba (56°33'50"N, 94°04'55"W), at an elevation of 185 m. This sample was submitted by J. Veillette to gain information on the nonglacial deposits and provide a comparison date for TL and OSL.

Comment (M. Roy): The sample was collected from a river-bank section. The collection site was 16 m above the river level. The wood fragments were collected from a slightly deformed peat layer. The wood retrieved from the peat was compressed and humid. All the wood fragments taken from the peat were in excellent condition. The peat was sampled for paleoecological analysis as well, and the results show a pollen spectra reflecting a black spruce forest, with a high abundance of herb pollen suggesting a local open forest. The wood fragments were enclosed in a massive peat layer which was found in a nonglacial unit mostly composed of oxidized sand and gravel with few clay beds (photos taken). This nonglacial unit overlies the Amery and Sundance tills, the surface of the latter being deeply weathered (sketch available). Both tills are presumably older than the last interglacial. The overlying Long Spruce Till might represent the onset of the Wisconsinan glaciation. The nonglacial unit is correlated with the Nelson River Sediments (Nielsen et al., 1986). The original type-section of this facies is now flooded, therefore, a new radiocarbon date should be obtained on the unit. This section is an important new locality in northern Manitoba, and is one of the rare sites, accessible by road, where sub-till organic bearing sediments are exposed in the Hudson Bay Lowlands. The local stratigraphy is key in developing glaciological models including the evolution of the Laurentide Ice Sheet. A controversy exists as whether or not the TL dates of about 40 ka obtained from a nearby section are reliable (Berger and Nielsen, 1991). Samples for optical dating were collected above and below the peat layer. Optical dating on the clay overlying the peat yielded an apparent IRSL age of 121 ± 16 ka.

GSC-2567 Spruce Lake

uncorrected age: 4850 ± 60

The wood (*Picea*; identified by R.J. Mott (unpublished GSC Wood Report No. 77-50)) was enclosed in sandy organic bed underlain by silts with freshwater microfossils. Sample 'DU-77-317A 19/7/1' was collected by L.A. Dredge and M.F. Nixon on July 19, 1977, from the northwest arm of Spruce Lake, northern Manitoba (59°04.8'N, 96°45'W), at an elevation of 210 m. This sample was submitted by L.A. Dredge to gain information on the nonglacial, sub-till deposits related to a glacial readvance.

Comments (L.A. Dredge): The regional and local stratigraphic relationships suggested that late-glacial ice advanced into a glacial lake, depositing till and burying the marginal organic deposits. The sample was dated to determine a maximum age for this final ice advance. The date obtained appears to be far too young for this interpretation to be correct in light of other dates from northern Manitoba, but a similar young age of 5220 ± 340 years (Y-231; Preston et al., 1955, p. 959) on peat overlain by more than 1 m of till(?) has been obtained from Rankin Inlet (cf. Lee, 1959).

RADIOCARBON DATES OF PALEONTOLOGICAL AND GEOARCHAEOLOGICAL INTEREST (Fig. 12)

BGS-617 Hubbell Creek

uncorrected age: 10 300 ± 200

The bison bone was enclosed in gravel spit deposits. Sample 'Bone No. 1' was collected by E. Nielsen and E.M. Gryba on July 16, 1978, from a gravel pit (B), near Hubbell Creek, 13 km northwest of town of Swan River on flanks of Porcupine Hills, west central Manitoba (52°11'18"N, 101°25'15"W), at an elevation of 351 m. This sample was submitted by E. Nielsen to gain information on paleontology.

Comment (E. Nielsen): In terms of taxonomy, none of the available elements is of use for precise determination. It is likely that the bison from this spit complex can be referred to either *Bison bison occidentalis* or *B. bison antiquus*. Although contemporary bison exhibit broad ecological tolerances, it is believed that even in the past these mammals were more numerous on grasslands and in deciduous woodlands than in coniferous forests. In the Russell area, about 150 km south of Hubbell Creek, a shift from forest dominated by *Picea* and *Artemisia* to grassland occurred about 10.5 ka BP (Ritchie, 1976). A similar change from spruce-dominated environment to open grassland is reflected by data from pollen sites at the eastern end of Riding Mountains, 110 km east of Russell (Ritchie 1964). The evidence also suggests that a 50-100 km belt of deciduous forest separated the boreal forest from the grasslands north of the 52nd parallel of latitude: on Duck Mountain birch-dominated forests replaced the early spruce forest about 9-10 ka BP (Ritchie, 1976).

BGS-1019 'Waggle Springs'

uncorrected age: 6300 ± 100

The bone, horn core (*Bison bison antiquus*; identified by M.C. Wilson) was enclosed in calcareous silt and clay. The sample was collected by L. Pettipas in 1984, from a cutbank on Assiniboine River near 'Waggle Springs', about 18 km east-southeast of Brandon, Manitoba (49°47'N, 99°43'W). This sample was submitted by E. Nielsen to gain information on mid-Holocene paleobiology.

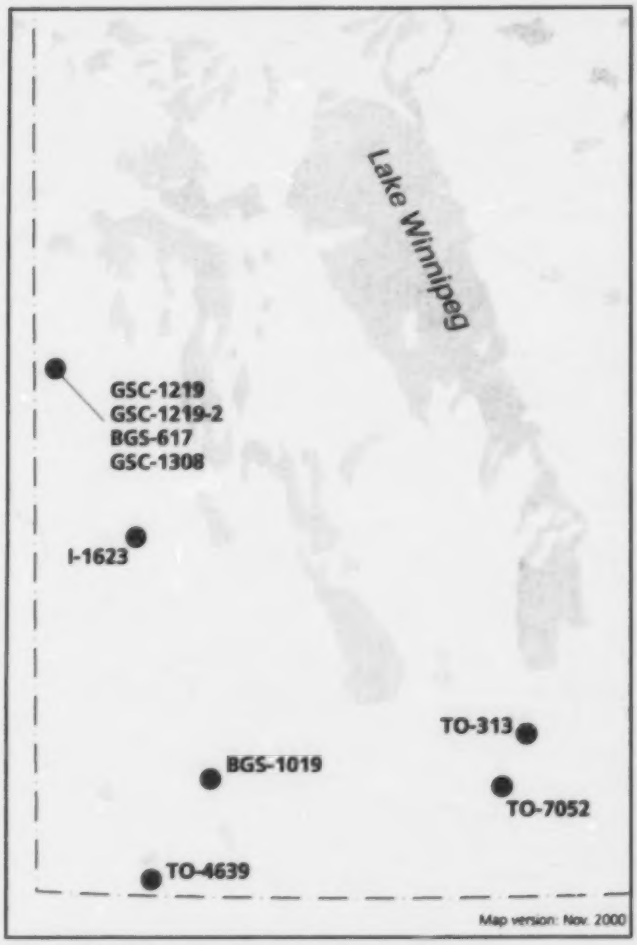

Figure 12. Radiocarbon dates on paleontological and geoarchaeological materials.

A Report on a *Bison* Horn Core from the Assiniboine River valley near Brandon, Manitoba

by M.C. Wilson

Introduction:

A large bison horn core was submitted to the author by E. Nielsen for analysis. The specimen was collected as 'float' from a disturbed context in the Assiniboine River valley area near Brandon, Manitoba. The present report summarizes the morphological characteristics of the specimen and provides a preliminary taxonomic assignment.

Condition:

The bison horn core was in relatively good condition, with a fresh break through the frontal 2 to 3 cm medially to the burr. The distal portion of the core was also broken away, possibly by a fresh break. Some of the distal break is discoloured, suggesting antiquity, but the simple transverse nature of the break is a pattern to be expected for leached bone and hence is post-depositional. The specimen reveals very little abrasion and therefore does not appear to have been transported far from its site of origin. The bone is a light buff ("manila envelope") colour, and this colour is often associated with leached bones from oxygen-rich depositional contexts. Coupled with the degree of leaching this colour would suggest an earlier Holocene context.

Description:

The specimen is the right horn core of a mature male bison, and is both long and robust. The burr exhibits prominent exostoses, particularly on the anterior aspect, and this suggests an animal on the order of 10 years of age or more. Two broad depressions are present on the core. One is on the superior surface near the burr and is about 40 mm across. It is crossed by several vascular grooves that could indicate a reactive condition in response to trauma. The second depression is on the anterior aspect at the burr and is 54 mm long (transversely) by 30 mm high. Radiating reactive tissue strongly suggests a tissue development in response to trauma. There is no median superior groove proximally but one is weakly developed distally. The core is ovoid in cross-section with a slight keel rotated toward the anterior core surface from the venter. The core appears to have had a slight posteriad deflection, but such a small portion of the frontal remains that the angle of posterior deflection cannot be

judged accurately. The anteroventral aspect of the core in the vicinity of the keel is strongly ridged and fluted. Measurements can only be taken from the base of the core. Length cannot be estimated accurately but was apparently about 300 mm on upper curve.

Following measurement criteria (and numbers) provided by Skinner and Kaisen (1947), the following data are available:

6. Vertical diameter of horn core at base	100 mm
7. Circumference of horn core at base	335 mm
12. Transverse diameter of horn core at base	105 mm

Diagnosis:

Given the paucity of information available, it is difficult to place the specimen taxonomically. Among the important criteria is the angle of posterior horn core deflection (Skinner and Kaisen 1947; Wilson 1974), important in distinguishing the early Holocene forms *Bison antiquus* and *B. bison occidentalis*. On the basis of horn core measurements provided by Skinner and Kaisen (1947), Wilson (1974) and Frison, Wilson and Wilson (1976) the specimen is more typical of *B. bison antiquus* inasmuch as measurements Nos. 6 and 7 fall very close to the maxima for *occidentalis*. However, confident reference of specimens to these subspecies cannot be made on the basis of the morphology of an individual specimen (Wilson 1974, 1978; Frison, Wilson and Wilson 1976). A direct comparison with an 11 000-year-old *antiquus* cranium from the Bighill Creek formation at Cochrane, Alberta (Wilson and Churcher, 1984) reveals close similarities in morphology, supporting this tentative identification.

Age:

It appears that, on the northern plains at least, *B. bison antiquus* preceded *B. bison occidentalis* (Wilson 1978; Frison, Wilson and Wilson 1976). If the identification as *antiquus* is correct, an early Holocene or a late Pleistocene age would be likely. However, the extremely tentative nature of the assignment is emphasized. *Bison* as robust as this specimen did persist into mid-Holocene times, albeit as population extremes.

Swan River valley Series

A series of samples from at the toe of the Upper Campbell beach, Swan River valley, Manitoba (52°12'N, 101°25'W), at an elevation of 350 to 358 m, was collected by L. Pettipas in July, 1968 and by E.M. Gryba in August, 1969. These samples were submitted by R.W. Klassen and L. Pettipas to gain information on the geoarchaeology of the Swan River site.

GSC-1219 Swan River valley I

normalized age: 2320 ± 130
$\delta^{13}C$= -21.2‰
uncorrected age: 2260 ± 130

The terrestrial bone sample from 0.6 m depth was at the contact zone between peat and underlying lacustrine sediments. Part of a collection of butchered bone fragments from the site was used for dating.

GSC-1219 2 Swan River valley II

normalized age: 2270 ± 130
$\delta^{13}C$= -21.2‰
uncorrected age: 2210 ± 130

This is a re-dating of the material used for GSC-1219.

Due to disturbance of overlying peat by road construction, the depth sampled varied, but was about 0.6 m. This type of deposit described by Ehrlich et al. (1962) as 'Shallow Peat', ranged from 0.3 to 0.9 m depth. The sample dated was part of collection of butchered bone fragments from site.

GSC-1308 Swan River valley III

normalized age: 2330 ± 130
$\delta^{13}C$= -24.9‰
uncorrected age: 2330 ± 130

The basal organic material, 'sample-2' from about 75 cm depth, was at the base of a bog comprising woody peat. This 'Shallow Peat' of Ehrlich et al. (1962); is decomposed aquatic muck according to M. Kuc. Natural vegetation at site consists of spruce and tamarack. Underlying parent material is composed of Lake Agassiz (Upper Campbell beach) sands and clays, the upper portion bearing evidence of gleying.

Comment (L. Pettipas): This site is an early prehistoric campsite with side-notched projectile points resembling those found in Iowa in the Logan Creek Complex. Earlier date (GSC-1219; 2320 ± 130; Lowdon et al., 1970, p. 475-476) was run on bone from an archaeological component of the same site.

Comment (W. Blake, Jr.): The sample dates occupancy of the site and is much younger than Upper Campbell beach, which is about 9500 years old (Elson, 1967; cf. also Klassen, 1969). Although dates on material from Lake Agassiz beach were far younger than expected (cf. Elson, 1967) agreement between collagen fraction of butchered bone and organic sediment at same depth is striking. Recovery of collagen, giving a result of 2270 ± 130 years (GSC-1219 2), is reported in Lowdon, et al., 1971, p. 258-259.

Note: other publications have different coordinates to those listed above.

52°18'N	101°25'W
52°11'20"N	101°28'55"W
52°11'N	101°28'W

I-1623 Valley River

uncorrected age: 8620 ± 190

The muskox skull bone (*Ovibos moschatus*; identified by C.R. Harington) was enclosed in sand and gravel underlying 3 m of alluvial sand and gravel. Sample 'W.O. No. 3 0344-261' was collected by R.W. Klassen in 1963, from the slip-off slope at a meander bend on the south side of Valley River about 5 km east of Grandview, Manitoba (51°11'N, 100°38'W). This sample was submitted by R.W. Klassen to gain information on paleontology.

Comment (R.W. Klassen): It is inferred that muskox herds inhabited a tundra-like environment in the Duck Mountain area after having survived Wisconsinan glaciation in a refugium to the south.

Coordinates originally reported as 51°11'N 101°38'W.

TO-313 Birds Hill esker

normalized age: 940 ± 70

The mammoth tusk fragments were enclosed in sand, the associated gravel was about 70% dolomitic limestone. Sample 'V1932' from about 20 m depth was collected by P. Taylor on April 18, 1986, from a sand and gravel pit in Birds Hill esker, northeast of Winnipeg, Manitoba (49°59'N, 96°53'W; SE5-12-5E),

at an elevation of about 260 m. This sample was submitted by G. Matile to gain information on paleontology.

The age is normalized to a $\delta^{13}C$ of -25‰.

Comment (G. Matile): The mammoth was probably extinct at the time of the deposition of the Birds Hill esker and therefore this material was re-deposited at this site, having originated from the last interglacial (Mid-Wisconsin) period.

IsoTrace Laboratory comment: As no organic fraction could be isolated for dating, the apatite fraction was used instead. The carbonate fraction was dissolved in glacial acetic acid, isolating the apatite which represented 22% of the total weight. CO_2 from the apatite was released by hydrolysis in concentrated H_3PO_4. The total carbon of this CO_2 represented only 0.9% of the weight of the apatite fraction. The apatite fraction was dated (above), then the carbonate fraction was dated indicating age of 12.9% modern. In view of the small amount of carbon, released from the sample, and the unreliability of inorganic fractions for dating, the resulting age does not reflect the real age of the sample but is a measure of sample contamination through exchange.

Mammoth Tusk Analysis

by R.G.V. Hancock and L.A. Pavlish

Introduction:

A chemical analysis of a mammoth tusk was carried out at the SLOWPOKE Reactor facility of the University of Toronto on behalf of the ISOTRACE facility of the University of Toronto for the purpose of determining uranium, phosphorus and calcium concentrations. These determinations, coupled with information gained from the radiocarbon sample preparation laboratory, permit estimates to be made about the degree of diagenetic change that the mammoth tusk has undergone during its burial history.

Analytical Procedure:

Twelve samples were packaged in trimmed 1 mL polyethylene vials (Olympic Plastics, California, U.S.A.). Individual samples were then irradiated sequentially for 2 minutes at a thermal neutron flux of 1 x 1011 n cm^2/s. After a delay time of twelve minutes each sample was assayed for 300s with a Ge(Li) spectrometer. The raw spectral data for all samples was then converted into elemental concentrations by comparison of individual isotopic net peak areas with predetermined standard values. To determine phosphorus, the samples were irradiated again under identical conditions while wrapped in cadmium foil, and assayed as before. From the decrease in the ^{28}Al production relative to the first irradiation, the real concentrations of Al and P were determined using the following parameters; Al/P sensitivity = 684; Al/cadmium ratio 15:1; and, P/cadmium ratio 1:1.

Results:

Seven of the twelve samples were from the interior sections of the tusk. Five were from the surface with each of these having a progressively greater amount of surface area per unit weight. Table I shows the results for the interior samples.

Table I. *Mammoth* tusk

INAAResults (of primary interest)

U	0.69	(0.30)	Mn	50	(6)
Ba	205	(40)	Cl	800	(120)
Sr	430	(80)	F	200	(10)
Mg%	0.78	(0.05)	P%	12.5	(1.5)
Si%	Trace		Ca%	35.7	(1.3)
Na%	0.290	(0.020)			

Interior Samples (n=7)

The uranium concentrations obtained for the surface samples increased as a function of increasing surface area and decreasing absolute weight. The results in order of decreasing weight in ppm are: 1.06 (0.18); 2.24 (0.39); 13.14 (0.24); 29.15 (1.5) and 32.6 (0.60). Therefore, the surface of the tusk contains the majority of the uranium in a concentration in excess of 30 ppm. Calcium concentrations are also slightly lower near the surface of the tusk averaging 30.0 (1.0)%.

Discussion:

Ivory has a chemical makeup similar to that of modern cortical bone with 55.0 ± 4% mineral content by weight. The calcium in hydroxyapatite, $Ca_{10}(PO_4)_6(H_2O)$, in the tusk at the time of deposition would have been between 20% and 24%. Likewise, the phosphorus would have been between 11% and 13.5% and the fluorine would have ranged between 100 and 600 ppm. These observations have been substantiated by comparing modern ivory with both ivory recovered from archaeological sites and geological ones. Uranium concentrations on the surface of calcium-rich materials will be spatially variable, and on the average seem to range between 5 and 30 ppm. Therefore, the uranium content of the tusk is not unusual. The IsoTrace sample preparation laboratory was able to dissolve in acid about 4/5ths of the tusk in question. Only 22% of the tusk was still made up of insoluble apatite. While 62% of the apatite has been chemically altered to soluble compounds, the presence of phosphorus in concentrations that are consistent with unaltered bone mineral suggest that leaching of inorganic constituents from the tusk has not taken place. The movement of phosphorus into the bone is unlikely because the mineral formed in the process (eg., Vivianite, $Fe_3(PO_4)_2.H_2O$ would require the tusk to have a diagenetic mineral content in excess of 10% (in this case iron). The *in situ* formation of tri-calcium orthophosphate $Ca_3(PO_4)_2$ provides one reasonable explanation for the presence of phosphorus concentrations consistent with fresh bone. Diagenetic alteration to the tusk has been primarily confined to the $CaCO_3$ occupying the former organic sites, and a small percentage of the altered apatite sites.

Table II. An approximation of the mineral makeup of the tusk

Mineral	% by wt.	Ca (%)	P (%)	Solubility
$Ca_{10}(PO_4)_6(OH)_2$	22.0	8.5	4.0	-
$Ca_3(PO_4)_2$	42.5	16.5	8.5	+
$CaCO_3$	30.0	11.0	-.-	+
	94.5	36.0	12.5	
MgO	1.0			
Na	0.25			
	95.75%			

- based on both the laboratory and reactor results.

Conclusion:

We conclude that the tusk has undergone little diagenetic change although there has been substantial alteration of the tusk apatite *in situ*. Uranium concentrations are within normal concentration ranges.

TO-4639 Turtle Mountain

normalized age: 33 860 ± 330

The Mammoth tusk was enclosed in gravel. Sample 'FI-94-0037' was collected by C. Black on July 15, 1991, from on the northern flank of Turtle Mountain, 22 km southwest of Boissevain and 19 km southeast of Deloraine, Manitoba (49°06'00"N, 100°17'00"W), at an elevation of 590 m. This sample was submitted by R.J. Fulton to

gain information on paleontology, a sub-till deposit, and to provide a limiting age for advance of last ice sheet.

The age is normalized to a $\delta^{13}C$ of -25‰.

Comment (R.J. Fulton): The tusk piece was recovered during gravel pit operations. It was assumed to have come from a sub-till gravel. The age is a minimum for the last ice sheet advance into this area, but probably predates this event by at least 10 ka (Fulton, 1995).

TO-7052 St. Agathe

normalized age: 5550 ± 70

The bone fragments (possibly a *Bison* rib, according to R.E. Morlan) were enclosed in silty clay and clay, associated with two Oxbow style projectile points and a hearth. Sample 'DjLg-10a' from 3 m depth was collected by G. Hill and E. Nielsen on August 29, 1997, from a borrow pit in the upper terrace along the shore at Red River, 3 km northeast of St. Agathe, Manitoba (49°35'05"N, 97°08'45"W), at an elevation of about 234 m. This sample was submitted by E. Nielsen to gain information on the geoarchaeology of this site, and paleontology.

The age is normalized to a $\delta^{13}C$ of -25‰.

Comment (E. Nielsen): This sample is from the same pit and the same depth as sample 'RR-97-6' (GSC-6254; 5570 ± 80) except it is from the south side of the pit.

Comment (R.E. Morlan): The sample is associated with two Oxbow style projectile points and a hearth. The bone fragments have been fractured consistent with human intervention and one fragment was charred (not used for dating), but there were no obvious cut marks or animal gnawing.

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[4] AMS - denotes samples dated at the Beta Laboratory by the AMS technique
HP - 'High Pressure' i.e. the 5 L counter at 4 atmospheres
OF - 'Outer Fraction' of a shell, usually 50% after initial leach
IF - 'Inner Fraction' of a shell, i.e. the remainder of the shell after the 'OF' reaction
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GX -2062	108
GX -2063	108
GX -3527	123
GX -3528	125
GX -3530	123
GX -3531	123
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GX -5644	57
GX -5645	57
GX -5646	57
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GX -5650	56
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GX -6300	57
GX -10863	33
GX -10864	33
GX -10865	33
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GX -23489	25
GX -23491	26
GX -23492	26
I -1086	38
I -1255	24
I -1511	17
I -1512	17
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I -1623	131
I -1682	17
I -2106	19
I -3156	18
I -3157	18
I -3472	19
I -3473	19
I -3474	19
I -3475	19
I -3476	18
I -3585	19
I -3586	19
I -3587	19
I -3820	19
I -4272	17
I -4273	17
I -4274	17
I -4276	17
I -6033	20
I -6264	20
I -6265	20
I -6267	20
I -6591	114
I -8048	39
QU -155	9
QU -314	9
QU -315	9
QU -316	9
QU -1286	13
QU -1287	12
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QU -1429	13
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RIDDL -1273	33
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S -129	18
S -446	56
S -588	32
S -738	111
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S -2472	40
S -2473	41
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S -3664	26
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TO -3285	125
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TO -6733	28
TO -6976	28
TO -6977	28
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TO -6985	29
TO -6986	29
TO -6987	29
TO -6988	29
TO -6989	29
TO -7052	133
W -860	30
W -862	30
WIS -1	44
WIS -25	47
WIS -60	47
WIS -66	47
WIS -72	47
WIS -112	47
WIS -113	47
WIS -131	47
WIS -146	44
WIS -153	43
WIS -170	43
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WIS -179	43
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WIS -286	42
WIS -287	42
WIS -289	42
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ARCHAEOLOGICAL RADIOCARBON DATES IN MANITOBA

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INTRODUCTION

The Canadian Archaeological Radiocarbon Database (CARD) contains 354 radiocarbon dates from archaeological and vertebrate paleontological sites in Manitoba. Several researchers have previously compiled archaeological radiocarbon dates from Manitoba. Wilmeth's (1971) nationwide listing, as of 1969, included only ten dates from the province. Dickson (1976) listed 32 dates from northern Manitoba, and Wilmeth's (1978) second national list contained 37 Manitoba dates. Syms (1983) presented descriptions of 24 dates that had been submitted to the Saskatchewan laboratory between 1971 and 1979, and Nicholson (1994b) summarized 34 dates that resulted from research at Brandon University. CARD has benefited from these predecessors, but it differs from them in several respects. It seeks to provide comprehensive coverage of the province, drawing upon both published and unpublished sources of information. It also incorporates all known dates on vertebrates, whether or not they are considered to be directly relevant to archaeology. The vertebrate record from Manitoba is quite incomplete and must be read mainly from those archaeological sites containing well preserved bones that have been thoroughly studied. However, there are a few isolated finds of vertebrate remains that offer information on the spatial and temporal distributions of conditions suitable for habitation.

CARD addresses the problem of normalizing radiocarbon dates to correct for the effects of isotopic fractionation. Whenever possible, each date is presented as an uncorrected age and as a normalized age, the latter being calculated from a measured or estimated ^{13}C ratio. The normalized ages conform to the definition of "conventional" ages (Stuiver and Polach, 1977): they have been calculated with the Libby half-life; they reference AD 1950 in years BP; they are normalized to $\delta^{13}C = -25‰$; and no corrections have been applied for reservoir effects or secular variations in ^{14}C concentrations. All errors represent ± 1 sigma, except for GSC dates that are quoted at ± 2 sigma. There may be differences among the laboratories as to the variables considered in calculating the errors, but data are not available to adjust the errors.

The spatial distribution of Manitoba radiocarbon dates is by no means uniform, and large parts of the province contain no dated archaeological or paleontological sites (Table 1).

Table 1. Manitoba archaeological dates by Borden block.

IM*	0	IL	6	IK	4	–	–
HM*	0	HL	33	HK	0	HJ*	0
GM*	0	GL	20	GK*	3	–	–
FM*	37	FL	0	FK*	0	–	–
EM*	6	EL	52	EK*	35	–	–
DM*	60	DL*	98	DK*	0	–	–

*portion of block is outside Manitoba

The temporal distribution of Manitoba radiocarbon dates is also very uneven. Nearly all of the dates refer to the last half of the Holocene (Table 2).

Table 2. Manitoba archaeological radiocarbon dates by millennium.

Millennium	Dates
0-1000	146
1001-2000	103
2001-3000	33
3001-4000	34
4001-5000	12
5001-6000	8
6001-7000	6
7001-8000	2
8001-9000	2
9001-10 000	3
10 001-17 000	3
33 001-34 000	1
>31 000	1

Since the great majority of these dates fall within the last 2000 years, corrections for isotopic fractionation, ranging from -35 to +410 years among Manitoba samples, are very important for establishing a reliable chronology. The Manitoba dates are summarized by material type in Table 3, along with the frequencies of measured ^{13}C ratios, the estimated ^{13}C ratios, and the correction formulae.

Table 3. Manitoba archaeological radiocarbon dates by material type.

Material dated	Number of dates	Anomalous Dates	Measured $\delta^{13}C$	Estimated $\delta^{13}C$ (‰)	Correction formula
marine shells	1	–	–	-0	+410 ± 70
freshwater shells	2	–	–	-8	+275 ± 50
bone apatite	5	–	–	-10	+245 ± 35
bone collagen	202	13	33	-20	+80 ± 20
charcoal and bone collagen	1	–	–	-25	none
charcoal	120	8	16	-25	none
wood	14	2	2	-25	none
grass or plant material	2	–	1	-25	none
organic sediment	3	–	1	-25	none
soil humic acid	1	1	–	-25	none
peat	2	–	2	-27	-35 ± 95
Unknown	1	–	–	–	–
Total	354	25	55		

Most of the dates have been obtained from samples of bone or charcoal (Table 3). Most of the bone dates are based on collagen or gelatin extractions. Many of the collagen dates were run prior to the method developed by Longin (1971). Such extraction methods carry a risk of failing to remove relatively young contaminants from the sample. Only 55 samples have reported $\delta^{13}C$ measurements, and the others must be normalized by assuming the values and applying the corrections shown in Table 3 (Morlan, 1999; Stuiver and Polach, 1977).

The Manitoba dates span the cultural record of the province and provide ages for vertebrate remains from mid-Wisconsinan to late Holocene time (Table 4). To aid the selection of records in the digital version of this database, the cultural sequence has been divided into three periods or stages – Palaeoindian, Archaic, and Woodland – and the Palaeoeskimo and Taltheilei traditions are distinguished as separate entities. No claim is made that this arrangement represents a satisfactory classification of ancient cultural traditions. The choice of terms is familiar to most workers and is intended only to aid retrieval of data.

The Manitoba samples have been analyzed by 17 laboratories (Table 5), mainly by decay counting, but in some cases by accelerator mass spectrometers (AMS). It is assumed that all of the AMS dates have been reported as ages normalized to $\delta^{13}C = -25‰$.

Table 4. Manitoba archaeological radiocarbon dates by significance.

Significance terms	Dates	Anomalous
geoarchaeology	2	–
palaeobiology	29	1
Palaeoindian	2	1
Archaic, unspecified	9	1
Oxbow	6	–
Oxbow, Duncan, Hanna	4	–
McKean	1	–
Duncan, Hanna	2	–
Duncan	1	–
Lee River complex	2	–
Pelican Lake, including Larter	13	–
Shield Archaic	10	–
Woodland, unspecified	38	2
Besant	7	1
Avonlea	6	1
Middle Missouri	3	1
Vickers	8	–
Laurel	30	5
Laurel, Blackduck	1	–
Blackduck	51	1
Clearwater Lake	12	4
Selkirk	17	2
Late Woodland	2	–
Taltheilei	6	–
Palaeoeskimo, Predorset	2	–
Palaeoeskimo, Dorset	1	–
Protohistoric	8	2
Historic	2	–
Cultural affiliation unknown	79	3
Total	354	25

Table 5. Manitoba archaeological radiocarbon dates by laboratory.

Lab	Laboratory	Country	No. of Dates
A	University of Arizona	U.S.A.	11
AECV	Alberta Environmental Centre at Vegreville	Canada	14
Beta	Beta Analytic Inc. (7 = AMS)	U.S.A.	19
BGS	Brock Geological Sciences	Canada	45
CAMS	Center for AMS, Livermore	U.S.A	10
DIC	DICAR (Radioisotope) Corp.	U.S.A.	7
GaK	Gakushuin University	Japan	40
GSC	Geological Survey of Canada	Canada	8
GX	Geochron Laboratories	U.S.A.	44
I	Teledyne Isotopes	U.S.A.	12
NSRL	Nuclear Structure Research Lab (AMS)	U.S.A.	6
OxA	Oxford University (AMS)	England	4
RIDDL	SFU ● McMaster University (AMS)	Canada	2
S	Saskatchewan Research Council	Canada	115
SFU	Simon Fraser University	Canada	8
TO	IsoTrace Laboratory, Toronto (AMS)	Canada	8
Y	Yale University	U.S.A.	1
Total			354

If the user knows only the name of a site, its Borden designation can be found in Table 6.

Limitations: Despite many inquiries to many people, the existing data are incomplete. In one case, the laboratory number is unknown, although the laboratory has been identified. In one case, the material dated is unknown. In many cases, sample provenience is unknown or vaguely presented. Some designations of cultural affiliation may be out-moded or incorrect.

It is possible that a few of the dates presented as measured ages have in fact already been normalized, in which case the normalized age given here is meaningless. Laboratory protocols vary considerably in reporting ^{13}C measurements. Some laboratories, such as Saskatchewan, leave it to the user to calculate the normalized age even if the ^{13}C ratio has been measured. Some laboratories, such as GSC, currently report both an uncorrected and a normalized age whenever a ^{13}C measurement has been made, but some past GSC date lists did not report the uncorrected age for such samples. Beginning early in its history, AECV routinely measured ^{13}C ratios and reported only normalized ages (L.D. Arnold, pers. comm., 1998), and it is assumed that all AECV dates from Manitoba have been normalized, whether or not the ^{13}C ratio has been reported by the archaeologist. The Beta lab initially reported only uncorrected ages unless the client requested a ^{13}C measurement, in which case both uncorrected and normalized ages were provided. Current practice is to estimate the ^{13}C ratio, if not measured, and to present both uncorrected and normalized ages for all samples. This is a satisfactory practice so long as the client (the archaeologist) passes along the information as to whether or not the stated age has been normalized. However, this information is omitted in many archaeological reports.

Acknowledgements

I wish to acknowledge assistance from Gary Dickson, Sid Kroker, Allison Landals, David Meyer, Ron Nash, Bev Nicholson, Erik Nielsen, and E. Leigh Syms, who provided dates and/or data for this date list. L.D. Arnold (formerly with the AECV lab), Roger McNeely (GSC), Howard Melville (BGS), Erle Nelson (SFU), and Jeff Zimmer (Saskatchewan lab) provided clarification of many technical matters. Peter Walker, Sites Information Officer, Historic Resources Branch, Manitoba Culture, Heritage and Citizenship, gave prompt and thorough attention to many requests for information concerning Borden numbers and other data. Morlan's contribution to this Open File report was supported by the Canadian Museum of Civilization (CMC). Ian Dyck, Curator of Plains Archaeology, CMC, was a constant source of encouragement and critical appraisal. The library staff at CMC, particularly Sylvie Laflamme, Inter-library Loans Officer, and Suzanne Perron, Circulation Librarian, provided generous and cheerful assistance.

Appeal for Help

If a user of this date list discovers errors or would like to suggest amendments to any of the data, the information should be forwarded to Richard E. Morlan, Canadian Museum of Civilization, P.O. Box 3100, Stn. B, Hull, Québec J8X 4H2; 819-776-8197, voice; 819-776-8300 fax; e-mail: richard.morlan@civilization.ca.

Table 6. Manitoba archaeological radiocarbon dated sites and Borden designation.

Site	Borden	Page	Site	Borden	Page	Site	Borden	Page
Aschkibokahn	FbMb-1	166	Heath Mound	DgMg-137	152	Ruby Street	DlLh-VP2	150
Astwood	EbKu-10	158	Heron	DiLv-14	143	Seahorse Gully	IeKn-6	175
Birds Hill	DlLf-VP	147	Hubbell Creek	FbMi-VP	168	Shethanei Narrows	IeLk-4	176
Bjorklund	EaLa-3	162	Jackson	DiMe-17	155	SIL 2	HcLx-2	172
Bottomly Creek	DlLg-VP2	150	Kain	DlLw-11	151	Sinnock	EcKx-4	159
Bowsman	FbMh-VP	167	Kain Cache	DlLw-12	151	Slave Falls	EbKv-34	158
Brockinton	DhMg-7	153	Kame Hills	HiLp-1	174	Snyder Dam	DhMg-37	154
C5-b	EfKv-6	159	Kuypers	DlLi-10	150	Snyder II	DgMg-15	152
Calf Mountain	DhLo-1	140	Lac du Bonnet	EbLb-no #	165	St. Andrews	EaLf-VP	164
Carberry	DlLt-VP	151	LM-8	EfKv-39	160	St. Boniface Hospital	DlLg-VP1	150
Caribou Hill	IhLa-1	176	Leaf Rapids Portage (SIL 1)	HcLx-1	172	St. James Mound	DlLh-1	150
Carrot River	FlMh-1	170	Lockport	EaLf-1	163	Star Mound	DgLq-1	140
Charcoal	DgMg-162	152	Long Point	HgLo-1	173	Steeprock Lake	FdMi-1	168
Cherry Point	DkMe-10	156	Lord	DkLg-1	146	Stendall	DkMh-1	156
Duck Lake Narrows	IiLk-1	176	Lovstrom	DjLx-1	144	Stott	DlMa-1	157
Duthie	DiMe-16	154	Lowton	DiLv-3	143	Swan River	FbMi-5	167
Egenolf Lake	IgLx-1	176	MacBride	HeLw-1	172	Thunderbird	EgKx-15	161
Elk Island	GdKn-1	170	Miniota	EaMg-12	165	Thyazzi	IfKs-1	176
Eriksdale	EfLl-no #	165	Mound G	DgMg-2	152	Treesbank	DjLv-VP2	144
Eveline Street Burial	EaLf-10	164	Mullett	DiMd-7	154	Tulabi Falls Portage	EcKt-15	158
Feland	DgMh-48	153	Nagami Bay	HgLt-1	174	Two Eagles	EcKw-14	159
Fidler Mounds	EaLf-3	164	Neck	HfLq-1	173	Vera	DiMe-25	155
Fire Island (SIL 184)	HfLp-11	173	Notigi Lake	GlLu-4	172	Victoria Day	GkLr-61	171
Flicker (SIL 257)	HeLw-20	173	Oscar Point	FgMc-2	169	Waggle Springs	DkLw-VP	147
(The) Forks	DlLg-33	147	Owiti	DjMd-4	155	Wanipigow	EgKx-1	160
Fort Alexander	EdLb-no #	165	Paddon	DlLg-1	147	Wapisu (UNR 26)	GkLs-1	171
Gods Lake	GdKn-3	170	Papegnies	DiLw-6	143	Wapisu Cairn	GkLt-20	172
Gompf	DkMd-3	155	Pas Reserve	FkMh-5	169	Wapiti Sakihtaw	DiLw-12	143
Good	DjMb-16	155	Portage diversion	EbLo-VP	158	Whaley Cairn	EbKx-10	158
Grandview	EhMd-VP	166	Reston	DkMg-1	156	Whitemouth Falls	EaLa-1	161
Hacault	DkLm-1	146	Richards village	DhLw-1	142	Wright	EaLg-9	164
Harris No. 1	DkLw-1	146	Rivermouth	EcKx-37	159	Wuskwatim (UNR 48)	GjLp-3	170
Harris No. 2	DkLw-1	146	Riverview Mound	DhMg-39	154			

ARCHAEOLOGICAL DATES (Fig. 1 and 2)

DgLh-VP: along the Red River, 225 m asl, 3.8 km north northeast of Emerson, Manitoba (NTS 62 H/03). This date was expected to provide information on the early development of upper terrace deposits. Sources: E. Nielsen, p.c. 1999.

S-3668 (RR-98-7), bison bone collagen, *Bison* sp. skull (id. by E. Nielsen), from silt exposed in the upper terrace, 14.5 m depth, collected 1998, submitted by E. Nielsen

normalized age:	2825 ± 70
	$\delta^{13}C$= -16.0‰
uncorrected age:	2680 ± 70

Note: Some minor root penetration was noted.

Significance: Palaeobiology

DgLq-1, Star Mound: on hummucky uplands of the Pembina River plain, 485 m asl, south-central Manitoba (NTS 62 G/01). This oblong tumulus, 43.6 m long, with a central body 21.3 m in diameter and 1.5 m high, is the most prominent part of a multiple mound burial and campsite complex. Excavations in 1914 by W.B. Nickerson revealed seven subgrade burial pits as well as burials both within and intruded into the mound fill. The top of pit D, sampled by Beta-111672, was sealed with large boulders.

Comment by I. Dyck: This date falls within the known range for radiocarbon-dated burial mounds in Manitoba (n=6), the oldest being Stott Mound (S-1303) and the youngest St. James Mound (I-4684). The date is anomalous with respect to the temporal range of the Devil's Lake-Sourisford burial complex to which Star Mound has previously been assigned. Thus the date does not resolve the identity of Star Mound, but it indicates some problems in the present cultural-historical framework of this area. Sources: Capes, 1963; Dyck, 1999.

Beta-111672 (AMS; CMC-1510), bison bone collagen, *Bison* sp. rib (12.5 g; id. by R.E. Morlan), from pit D, a 1 m deep pit at the center of the mound, below human bones of skeleton #14 which was about half way below the mouth of the pit, collected 1914.08, submitted by I. Dyck

normalized age:	1170 ± 70
	$\delta^{13}C$= -21.5‰
uncorrected age:	1110 ± 70

Significance: Woodland, unspecified

DhLh-VP1: along the Red River, 225 m asl, 1.7 km northeast of St. Jean Baptiste, Manitoba (NTS 62 H/06). This was a fresh natural exposure along the east bank of the Red River. The enclosing sediment was wet with no obvious plant growth. The ca. 4 m high section comprises 3 m of slumped yellow silt derived from the upper terrace. This is overlain by 1 m of grey laminated overbank deposits associated with the alluvial bench. The dated bones are from the top of the yellow silt. The date will help establish timing of the beginning of overbank deposition at this site. Sources: E. Nielsen, p.c. 1999.

S-3669 (RR-98-60), bison bone collagen, *Bison* sp. (id. by E. Nielsen), from top of 3 m of slumped yellow silt, 1 m depth, overlain by 1 m of gray laminated overbank deposits, collected 1998, submitted by E. Nielsen

normalized age:	2235 ± 60
	$\delta^{13}C$= -15.4
uncorrected age:	2080 ± 60

Significance: Palaeobiology

DhLh-VP2: 7 km south of Morris, about 228 m asl, about 68 km south of Winnipeg, in the Red River valley, Manitoba (NTS 62 H/06).

Comment by R.E. Morlan: The sample was a left tibia of a bison with the proximal end missing. Measurements of the distal end (breadth = 7.8 cm; depth = 6.0 cm) show that this bison was almost certainly an adult male. These measurements are near the upper end of the size range for modern Plains bison bulls, and it is possible that an older chrono-subspecies such as *B. bison occidentalis* is represented. The manner of removal of the proximal end of this bone is consistent with damage caused by large carnivorous mammals. However, no definite tooth-marks are preserved. The bone lay on the surface for a brief period (a few months?) prior to burial as shown by longitudinal cracking similar to Behrensmeyer's (1978) stage 1 weathering. While in the active layer, the bone was etched by plant roots, but the degree of etching is quite modest and the extent of etching is scattered and localized. Interruption of the etching process suggests a relatively short interval of time before deeper burial was achieved. There is no evidence of human intervention in the dismemberment or defleshing of this bison. Sources: R. McNeely, p.c. 1998.

S-3662 (RR-97-14), bison bone collagen, *Bison* sp. tibia (id. by R.E. Morlan), from calcareous silty clay in horizontally stratified alluvium, 4.8 m depth, a fresh exposure in a 6 m high section, collected 1997, submitted by E. Nielsen

normalized age:	5380 ± 90
	$\delta^{13}C$= -18.7‰
uncorrected age:	5280 ± 90

Significance: Palaeobiology

DhLo-1, Calf Mountain: "[a]round the west side of a slough on Hutterite land just south of the Calf Mountain sites [Pembina drainage, southern Manitoba (NTS 62 G/01)]. Many bones were observed" (Manitoba Culture, Heritage & Citizenship files). W.M. Hlady reports C. Vickers' opinion that GX-1192 represents the Manitoba (Blackduck) phase (Manitoba Archaeological Newsletter 10(1-2): 43, 1973). Sources: Manitoba Culture, Heritage and Citizenship files; Reeves, 1970, 1983; E.L. Syms, p.c. 1998.

GX-1192, bone collagen, from a road ditch cutbank with a Late Plains Woodland vessel having an S-shaped rim and cord-wrapped rod decoration, submitted by B.O.K. Reeves

normalized age:	1185 ± 85
	$\delta^{13}C$= -20‰e
uncorrected age:	1105 ± 85

Significance: Woodland, Blackduck

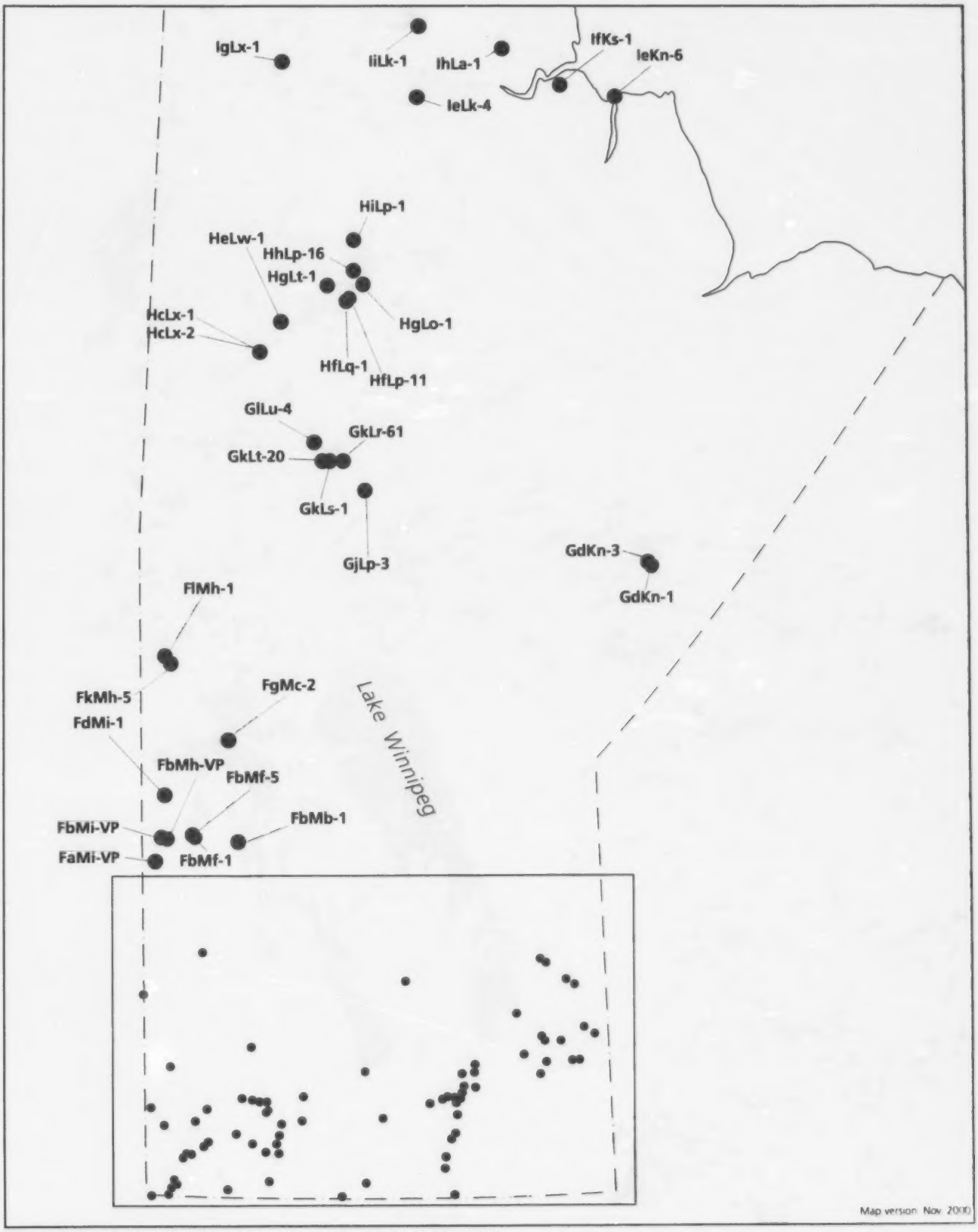

Figure 1. Distribution of archaeological radiocarbon dates in Manitoba.

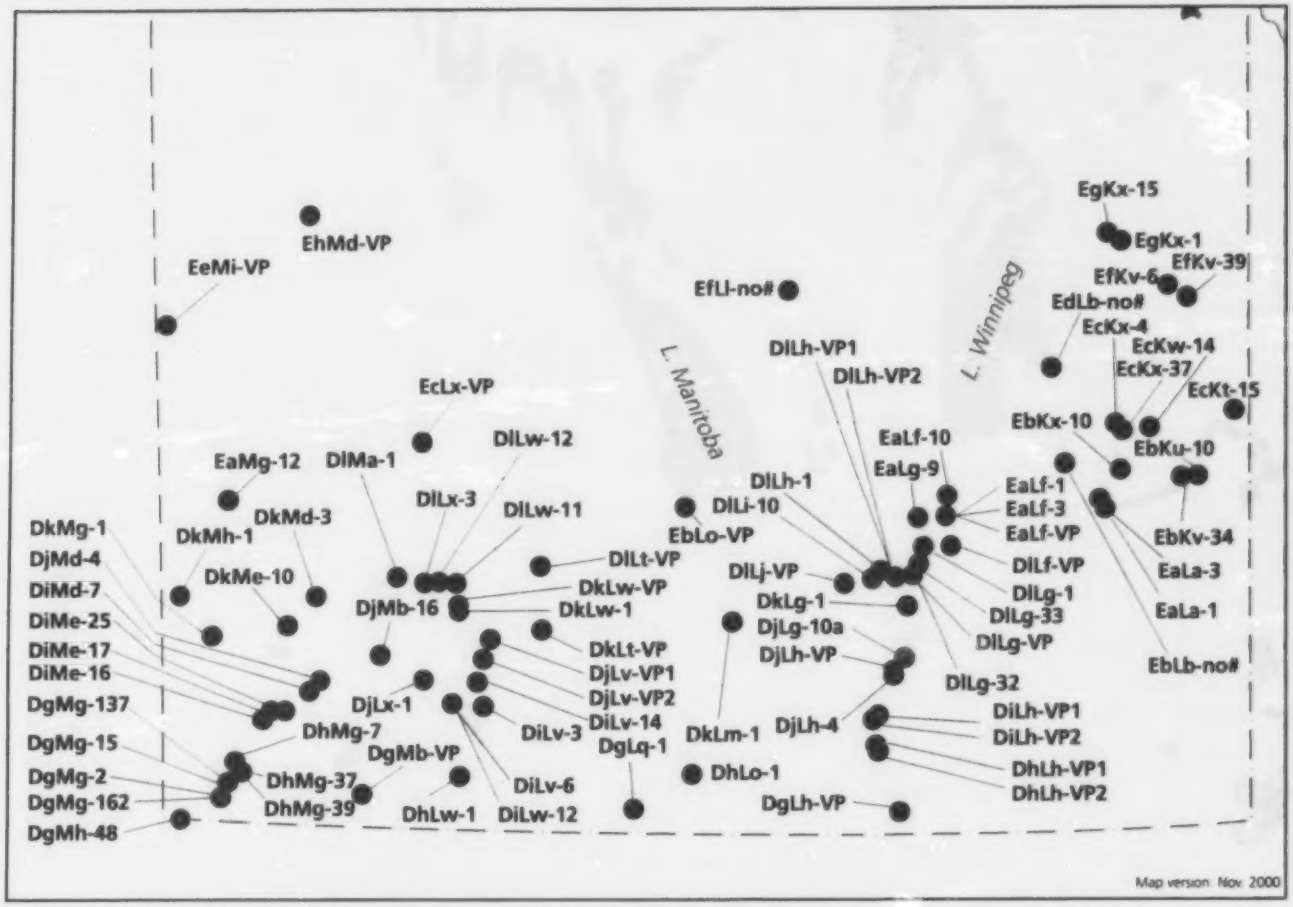

Figure 2. Distribution of archaeological radiocarbon dates in southern Manitoba.

DhLw-1, Richards village: near the Pembina River, between Turtle Mountain and Pembina valley, south-central Manitoba (NTS 62 G/04). Syms considers S-913 and S-1338 acceptable. W.M. Hlady rejects GX-1193 in favour of GX-2059 (Manitoba Archaeological Newsletter 10(1-2): 43, footnote, 1973), but neither sample has ever been adequately described in print. Sources: S-IX; Nicholson, 1987; Paulson, 1980, Reeves, 1970, 1983; Syms, 1983.

GX-2059, unknown material, from unreported provenience

normalized age:	1375 ± 120
	$\delta^{13}C$= ?‰
uncorrected age:	1375 ± 120

Significance: Woodland, Besant

S-913 (Br-74-1), bone collagen, from upper occupation level, collected 1973, submitted by E.L. Syms

normalized age:	1000 ± 65
	$\delta^{13}C$= -20‰e
uncorrected age:	920 ± 60

Significance: Woodland, Blackduck

GX-1193, bone collagen, from unreported provenience, submitted by B.O.K. Reeves

normalized age:	1320 ± 130
	$\delta^{13}C$= -20‰e
uncorrected age:	1240 ± 130

Significance: Woodland, Besant, anomalous, young

S-1338 (Br-77-1), bone collagen, from lower occupation level, Level 4-5, 16-20 cm depth, collected 1975, submitted by E.L. Syms

normalized age:	1510 ± 150
	$\delta^{13}C$= -20‰e
uncorrected age:	1430 ± 150

Significance: Woodland, Besant

DiLh-VP1: about 3 km northeast of Morris, about 60 km south of Winnipeg, about 228 m asl, in the Red River valley, Manitoba (NTS 62 H/06).

Comment by R.E. Morlan: This sample was a left bison tibia, wholly intact, with proximal and distal ends completely fused. Measurements of the distal end (breadth = 7.2 cm; depth = 5.1 cm) suggest that this bison was probably a relatively small adult bull. These measurements are near the lower end of the size range for modern Plains bison bulls and are smaller than the largest adult cow tibia in Morlan's comparative data. There is no evidence bearing upon the cause of death of this bison. The bone lay on the surface for a brief period (a few months?) prior to burial and is weathered to Behrensmeyer's (1978) stage 1. During this period on the surface, a rodent gnawed on a small area of the anterior crest. The bone may have entered into a relatively deep burial environment rather quickly, because there is no evidence of root-etching. Sources: R. McNeely, p.c. 1998.

S-3663 (RR-97-17), bison bone collagen, *Bison* sp. tibia (id. by R.E. Morlan), from silty and silty clay alluvium, 2.3 m depth, a fresh exposure in a 3 m high section, collected 1997, submitted by E. Nielsen

normalized age:	350 ± 70
	$\delta^{13}C$= -15.6‰
uncorrected age:	200 ± 70

Significance: Palaeobiology

DiLh-VP2: about 4 km northeast of Morris, about 58 km south of Winnipeg, about 228 m asl, in the Red River valley, Manitoba (NTS 62 H/06).

Comment by R.E. Morlan: This sample of bison bone fragments included part of a left temporal bone, three fragments from the upper part of the brain case, both left and right nasal bones, a thoracic vertebral centrum with the complete neural arch and base of the neural spine, and segments of two ribs of which one has an intact proximal end. Evidence of subaerial weathering and root-etching is minimal, and there is no sign of gnawing by carnivores or rodents, and no sign of butchering by people. The bones were probably deeply buried soon after the death of the animal(s). Sources: R. McNeely, p.c. 1998.

S-3664 (RR-97-18), bison bone collagen, *Bison* sp. bone fragments (id. by R.E. Morlan), from massive yellow silt underlying about 3.5 m of olive-coloured, laminated alluvium, 4.6 m depth, in a fresh exposure in the floodplain, collected 1997, submitted by E. Nielsen

normalized age:	1840 ± 80
	$\delta^{13}C$= -14.9‰
uncorrected age:	1680 ± 80

Significance: Palaeobiology

DiLv-3, Lowton: in the Tiger Hills glacial moraine uplands, 5 km east of the Souris-Pembina trench, southern Manitoba (NTS 62 G/05). Sources: Nicholson, 1996; Nicholson and Malainey, 1995.

S-3459, bone collagen, from cultural layer, submitted by B.A. Nicholson

normalized age:	590 ± 110
	$\delta^{13}C$= -20‰e
uncorrected age:	510 ± 110

Significance: Woodland, Vickers Focus

DiLv-14, Heron: situated in a swale in the Tiger Hills north of Ninette, Manitoba (NTS 62 G.12). Sources: Nicholson, 1994b, 1996, p.c. 1998.

S-3500, bison bone collagen, *Bison* sp. cervical vertebra, in bottom of swale, 30 cm depth, submitted by B.A. Nicholson

normalized age:	220 ± 140
	$\delta^{13}C$= -20‰e
uncorrected age:	140 ± 140

Significance: Cultural affiliation unknown

S-3460, bison bone collagen, *Bison* sp. long bone fragments, on slope, 30 cm depth, submitted by B.A. Nicholson

normalized age:	660 ± 100
	$\delta^{13}C$= -20‰e
uncorrected age:	580 ± 100

Significance: Cultural affiliation unknown

DiLw-6, Papegnies: north of Dunrea on the moraine lying to the north of Lang's Valley, in the Tiger Hill physiographic zone of the Pembina Valley trench, southern Manitoba (NTS 62 G/05). Sources: Low, 1994; Nicholson, 1996.

Beta-62706, bone collagen, from cultural layer, submitted by B.A. Nicholson

normalized age:	950 ± 75
	$\delta^{13}C$= -20‰e
uncorrected age:	870 ± 70

Significance: Woodland, Blackduck

DiLw-12, Wapiti Sakihtaw: at Big Tiger Hill, south-central Manitoba (NTS 62 G/05). Sources: Scribe, 1996; Scribe and Nicholson, 1994.

Beta-59415, bone collagen, from upper Levels 2-3, 5-15 cm depth, submitted by B.A. Nicholson

normalized age:	1220 ± 75
	$\delta^{13}C$= -20‰e
uncorrected age:	1140 ± 70

Note: This date may already have been normalized.

Significance: Woodland, unspecified

Beta-59414, bone collagen, from lower Levels 4-5, 15-25 cm depth, submitted by B.A. Nicholson

normalized age:	1660 ± 75
	$\delta^{13}C$= -20‰e
uncorrected age:	1580 ± 70

Note: This date may already have been normalized.

Significance: Woodland, unspecified

DjLg-10a: borrow pit in the upper terrace along the shore at Red River, about 234 m asl, 3 km northeast of Ste. Agathe, Manitoba (NTS 62 H/11). TO-7052 is from the same pit and same depth as GSC-6254 (5570 ± 80 BP) but on the south side of the pit.

According to R.E. Morlan, the bone fragments associated with TO-7052 may have been fractured by people, and one fragment, not used for dating, was charred. There were no obvious cut marks or animal gnawing. No cultural remains were found with GSC-6254. Sources: R. McNeely and E. Nielsen, p.c. 1998.

TO-7052, bison? bone collagen, *Bison*? sp. rib, from silty clay and clay, associated with two Oxbow style projectile points and a hearth, 3 m depth, collected 1997, submitted by E. Nielsen

normalized age:	5550 ± 70
	$\delta^{13}C$= ?‰

Significance: Archaic, Oxbow?

DjLh-4: about 5 km south of Ste. Agathe, about 40 km south of Winnipeg, about 228 m asl, in the Red River valley, Manitoba (NTS 62 H/11).

Comment by R.E. Morlan: This sample of bison bone fragments included portions of a right ankle assembly of a bull (distal tibia, lateral malleolus, talus, calcaneus, tarsal C+4), distal metatarsal, humerus shaft, and miscellaneous long bone and rib fragments. Some of these are not identifiable, but their association with the definite bison bones renders it likely that they represent the same species, perhaps the same individual animal. The bones exhibit almost no evidence of subaerial weathering and only very minor root-etching. There is no evidence of gnawing by rodents or carnivores. Some of the very robust long bone fragments appear to have been fractured when fresh, and they could reflect human butchery practices such as marrow retrieval. However, the evidence has been obscured by recently inflicted damage caused by vigorous excavation methods. Sources: R. McNeely, p.c. 1998.

S-3665 (RR-97-25), bison bone collagen, *Bison* sp. bone fragments (id. by R.E. Morlan), from silty and silty clay alluvium, 80 cm depth, in a freshly dug 5 m deep borrow pit, associated with an aboriginal hearth and a side-notched projectile point, collected 1997, submitted by E. Nielsen

normalized age:	2770 ± 80
	$\delta^{13}C$= -17.4‰
uncorrected age:	2650 ± 80

Significance: Cultural affiliation unknown

DjLh-VP: a natural river cutbank along the west bank of the Red River, 228 m asl, 3 km south-southwest of the intersection of highways 75 and 305 at the town of Ste. Agathe, southern Manitoba (NTS 62 H/11). The dated sample was one of three teeth which were part of a collection of broken pieces of bones. Most of the bones are poorly to moderately preserved and seem to have been weathered prior to deposition. The teeth, however, are well preserved (intact, enamel still present).

Preliminary interpretations of the cutbank indicate that the sample was contained within Holocene alluvial floodplain deposits. Specifically, the unit containing the sample represents point bar deposits formed from lateral accretion along the convex (or inner) bank of a meander. Successive accretion on this bank has resulted in the concomitant lateral construction of the floodplain and migration of the river channel. At present, the meandering channel of the Red River is laterally stable, however, the presence of floodplain deposits and the occasional meander scar along the river course indicates that it has experienced lateral migration processes in the past. The shift from an actively migrating to stable channel is believed to have been caused by the decrease in the valley slope imposed by the Holocene differential isostatic adjustment of southern Manitoba. The time intervals of active and inactive migration are presently not known. The age of this sample will a) represent a minimum age for the development of lateral channel migration processes on the glacial Lake Agassiz plain; b) fall within the period of active channel migration; and c) represent a maximum date for the transition from active to inactive channel migration. Sources: R. McNeely, p.c. 1998.

TO-6733 (97-June07-StA-CO1), bison bone collagen, *Bison* sp. molar (id. by R.E. Morlan), from silt-clay alluvium in point bar deposit overlying Glacial Lake Agassiz clay, collected 1997, submitted by G.R. Brooks

normalized age:	5430 ± 70
	$\delta^{13}C$= ?‰

Significance: Palaeobiology

DjLv-VP1: a river bank section along the Assiniboine River, about 345 m asl, 5 km east-northeast of Treesbank, Manitoba (NTS 62 G/12). A 10 m high section is composed of silt over sand, then pebbly sand of point bar sequence to 3 m depth, over sand with a pebble horizon and till at 4 m depth. Sources: Elson, 1967; Teller and Thorleifson, 1983.

BGS-1823 (ASSR95-03), bone collagen, from highly calcareous silt, 30 cm depth, associated with the Emerson phase of Lake Agassiz, collected 1995, submitted by E. Nielsen

normalized age:	2990 ± 80
	$\delta^{13}C$= -20‰e
uncorrected age:	2910 ± 80

Significance: Palaeobiology

DjLv-VP2, Treesbank: north bank of the Assiniboine River, 335-343 m asl, about 1.6 km downstream from the mouth of Souris River, 3.2 km north and 3.2 km east of Treesbank, Manitoba (NTS G/12). The wood-bearing sand dated by Y-415 is tentatively interpreted as part of the Assiniboine delta laid down in glacial Lake Agassiz. The sand overlies 2.4-3.0 m of gravel and sand resting on till. It is overlain by about 7.6 m of sand containing a fossil soil horizon, with aeolian sand at the surface. Sources: Y-III; Elson, 1962; Harington, 1970; Pettipas and Buchner, 1983.

Y-415, wood, from base of 4.5 m layer of silty sand containing bison? bones and wood, collected 1955, submitted by J.A. Elson

normalized age:	9110 ± 110
	$\delta^{13}C$= -25‰e
uncorrected age:	9110 ± 110

Significance: Palaeobiology

DjLx-1, Lovstrom: south of Brandon, on a till plain overlooking the Souris valley, 373.5 m asl, east of Jock's Creek, southwestern Manitoba (NTS 62 G/12). S-2823, assigned to the protohistoric period, was associated with gunflints made from local lithic material. Along with the Johnas site, Lovstrom contains evidence of extended occupations by people using agricultural tools and whose ceramic affiliations appear to relate to groups in North Dakota and western Minnesota known to have practiced horticulture. The two SFU dates from this site were among the last samples processed before the laboratory was decommissioned, and the reported dates are

preliminary results that should be treated with caution (D.E. Nelson, p.c. 1998). Sources: Nicholson, 1986, 1990, 1994b, 1996; Nicholson and Malainey, 1991.

S-3030, bison bone collagen, *Bison* sp., from soil/till, component 1, collected 1988.08.17, submitted by B.A. Nicholson

normalized age: <100
$\delta^{13}C$= -20‰e
uncorrected age: <100

Significance: Historic

S-2823, bison bone collagen, *Bison* sp., from test unit no. 22, component 1, collected 1986.07.16, submitted by B.A. Nicholson

normalized age: 310 ± 90
$\delta^{13}C$= -20‰e
uncorrected age: 230 ± 90

Significance: Protohistoric

SFU-no#1, bone collagen, large ungulate, from Block E, component 2, submitted by B.A. Nicholson

normalized age: 460 ± 55
$\delta^{13}C$= -20‰e
uncorrected age: 380 ± 50

Note: This preliminary result was never finalized or given a laboratory number (D.E. Nelson, pers. comm., 1998).

Significance: Woodland, Vickers Focus

S-3032, bison bone collagen, *Bison* sp., from Block H, component 2, collected 1988.08.17, submitted by B.A. Nicholson

normalized age: 485 ± 110
$\delta^{13}C$= -20‰e
uncorrected age: 405 ± 110

Significance: Woodland, Vickers Focus

S-3033, bison bone collagen, *Bison* sp., from Block E, component 2, collected 1988.08.17, submitted by B.A. Nicholson

normalized age: 545 ± 100
$\delta^{13}C$= -20‰e
uncorrected age: 465 ± 100

Significance: Woodland, Vickers Focus

SFU-no#2, bone collagen, large ungulate, from Block E, component 3, submitted by B.A. Nicholson

normalized age: 940 ± 55
$\delta^{13}C$= -20‰e
uncorrected age: 860 ± 50

Note: This preliminary result was never finalized or given a laboratory number (D.E. Nelson, pers. comm., 1998).

Significance: Woodland, unspecified

S-3131, bison bone collagen, *Bison* sp., from soil / till, component 3, collected 1988.08.17, submitted by B.A. Nicholson

normalized age: 680 ± 65
$\delta^{13}C$= -20‰e
uncorrected age: 600 ± 60

Significance: Woodland, unspecified

S-2952, bison bone collagen, *Bison* sp., from Block E, component 3, collected 1987.07.18, submitted by B.A. Nicholson

normalized age: 755 ± 75
$\delta^{13}C$= -20‰e
uncorrected age: 675 ± 70

Significance: Woodland, Blackduck

S-2953, bison bone collagen, *Bison* sp., from Block B, component 3, collected 1987.07.18, submitted by B.A. Nicholson

normalized age: 755 ± 80
$\delta^{13}C$= -20‰e
uncorrected age: 675 ± 80

Significance: Woodland, Blackduck

S-2951, bison bone collagen, *Bison* sp., from Block B, component 3, collected 1987.07.18, submitted by B.A. Nicholson

normalized age: 785 ± 80
$\delta^{13}C$= -20‰e
uncorrected age: 705 ± 75

Significance: Woodland, Blackduck

S-3034, bison bone collagen, *Bison* sp., from Block E, component 3, collected 1988.08.17, submitted by B.A. Nicholson

normalized age: 795 ± 110
$\delta^{13}C$= -20‰e
uncorrected age: 715 ± 110

Significance: Woodland, Blackduck

S-2824, bison bone collagen, *Bison* sp., from test unit no. 22, component 3, collected 1986.07.16, submitted by B.A. Nicholson

normalized age: 855 ± 90
$\delta^{13}C$= -20‰e
uncorrected age: 775 ± 90

Significance: Woodland, unspecified

S-3031, bison bone collagen, *Bison* sp., from Block H, component 3, collected 1988.08.17, submitted by B.A. Nicholson

normalized age: 860 ± 110
$\delta^{13}C$= -20‰e
uncorrected age: 780 ± 110

Significance: Woodland, Blackduck

S-3029, bison bone collagen, *Bison* sp., from Block C, component 3, collected 1988.08.17, submitted by B.A. Nicholson

normalized age:	930 ± 115
	$\delta^{13}C$= -20‰e
uncorrected age:	850 ± 115

Significance: Woodland, Blackduck

S-2699, bison bone collagen, *Bison* sp., from test unit no. 5, component 4, collected 1985.06.15, submitted by B.A. Nicholson

normalized age:	1295 ± 320
	$\delta^{13}C$= -20‰e
uncorrected age:	1215 ± 320

Significance: Woodland, unspecified

S-2700, bison bone collagen, *Bison* sp., from test unit no. 8, component 4, collected 1985.06.15, submitted by B.A. Nicholson

normalized age:	1360 ± 190
	$\delta^{13}C$= -20‰e
uncorrected age:	1280 ± 190

Significance: Woodland, unspecified

DkLg-1, Lord: on the Red River, at St. Norbert, Manitoba (NTS 62 H/14). Syms considers S-652 acceptable for early Blackduck. Sources: S-IX; Syms, 1976, 1977.

S-652 (UM-A-LAB2), bone collagen, from cultural layer, collected 1972, submitted by E.L. Syms

normalized age:	1250 ± 90
	$\delta^{13}C$= -20‰e
uncorrected age:	1170 ± 90

Significance: Woodland, Blackduck

DkLm-1, Hacault: 9.6 km west of Elm Creek, 4 km north of provincial trunk highway 2, Assiniboine drainage, Manitoba (NTS 62 G/09). This is an Oxbow site. Nero suggests that BGS-1717 may be unreliable because of permineralization of the bone. The BGS-1753 sample was not permineralized. Both dates are given by Nero as calibrations of the measured ages (E. Nielsen, p.c. 1998). Sources: Nero, 1997.

BGS-1753, bison bone collagen, *Bison* sp., from Test area B, collected 1993, submitted by E. Nielsen

normalized age:	2995 ± 125
	$\delta^{13}C$= -20‰e
uncorrected age:	2915 ± 125

Note: Nero gives a calibrated age, 3050 ± 125 BP, for this sample.

Significance: Archaic, Oxbow

BGS-1717, bison bone collagen, *Bison* sp., from Test area A, collected 1993, submitted by E. Nielsen

normalized age:	3230 ± 550
	$\delta^{13}C$= -20‰e
uncorrected age:	3150 ± 550

Note: Nero gives a calibrated ("corrected") age, 3360 ± 550 BP, for this sample. This date is suspect, because the bone was heavily mineralized.

Significance: Archaic, Oxbow

DkLt-VP: a river bank section along the Assiniboine River, about 320 m asl, 2 km west of Steels Ferry, Manitoba (NTS 62 G/11). A 10 m high section is composed of silt over pebbly sand over silty clay of point bar sequence in a well developed terrace. Sources: Elson, 1967; Teller and Thorleifson, 1983.

BGS-1824 (ASSR95-17), bone collagen, from highly calcareous silt, 1 m depth, associated with the Campbell level of Lake Agassiz, collected 1995, submitted by E. Nielsen

normalized age:	6430 ± 150
	$\delta^{13}C$= -20‰e
uncorrected age:	6350 ± 150

Significance: Palaeobiology

DkLw-1, Harris No. 2: on the Assiniboine River, 358 m asl, southeast of Brandon, Manitoba (NTS 62 G/13). S-519 occurred on Terrace 2 in a stratified context and provides nearly a terminal date for the use of a bison kill. The level includes late ceramics and lithic artifacts. A mixture of Manitoba (Blackduck) and Selkirk phases seems to exist. Sources: S-VI; Hlady, 1967, 1970; Simpson, 1966; Wilmeth, 1978.

S-519 (CMC-334), charcoal, from sq. N165, E5, level 2, 7.6-15.2 cm depth, collected 1967.08.27, submitted by W.M. Hlady

normalized age:	210 ± 50
	$\delta^{13}C$= -25‰e
uncorrected age:	210 ± 50

Significance: Woodland, unspecified

DkLw-1, Harris No. 1: on the Assiniboine River, 358 m asl, southeast of Brandon, Manitoba (NTS 62 G/13). The deepest occupation, at an average depth of 48-58 cm, in the top of gravels probably laid down as a strandline of glacial Lake Brandon, is associated with large flake tools. Above this is an occupation with average depth of 38-46 cm, containing large side-notched points, one of which was associated with GaK-1483 in the firepit. Uppermost is a thin deposit perhaps representing more than one occupation. GaK-1483 will date the middle occupation, estimated at 4000 to 7000 years.

Comment by Hlady: with another field season, the original estimate is recognized as much too early, and the date does not seem out of line. Large side-notched point associated with GaK-1483 is of a size which persisted as late as AD 300-400 in the Besant phase. Sources: GaK-VII; Hlady, 1967, 1970; Simpson, 1966; Wilmeth, 1978.

GaK-1483 (CMC-205), charcoal, from firepit, square 105n/10e, 44-58 cm depth, collected 1966.10.08, submitted by W.M. Hlady

normalized age:	2490 ± 100
	$\delta^{13}C$= -25‰e
uncorrected age:	2490 ± 100

Significance: Cultural affiliation unknown

DkLw-VP, Waggle Springs: Assiniboine River, near "Waggle Springs," Manitoba (NTS 62 G/13). The horn core was examined by M.C. Wilson who found it to be the right horn core of a mature male bison. The horn core is long and robust, exhibiting prominent exotoses suggesting an age at death of 10 or more years. Too little of the skull is attached to determine the angle of deflection, an important character from a taxonomic standpoint. However, the vertical diameter at the base of the horn core (100 mm), the transverse diameter at the base (105 mm) and the circumference at the base (335 mm) are very close to the maxima for *B. bison occidentalis* and are more typical measurements for *B.b. antiquus*. Sources: E. Nielsen, p.c. 1998; M.C. Wilson, unpublished report to E. Nielsen, 1984.

BGS-1019, bison bone collagen, *Bison bison* ssp. horn core (320 g; id. by M.C. Wilson), from calcareous silt and clay, eroded from alluvium, stratigraphic position uncertain, collected 1984, submitted by E. Nielsen

normalized age:	6380 ± 100
	$\delta^{13}C$= -20‰e
uncorrected age:	6300 ± 100

Significance: Palaeobiology

DlLf-VP, Birds Hill: northeast of Winnipeg, about 260 m asl, Red River valley, Manitoba (NTS 62 H/15). A mammoth tusk was eroded from the face of a gravel pit into the Birds Hill esker, from a depth of about 20 m below the surface. "As no organic fraction could be isolated for dating, the apatite fraction was used instead. The carbonate fraction was dissolved in glacial acetic acid, isolating the apatite which represented 22% of the total weight. CO_2 from the apatite was released by hydrolysis in concentrated H_3PO_4. The total Carbon of this CO_2 represented only 0.9% of the weight of the apatite fraction. In view of the small amount of carbon, released from the sample, and the unreliability of inorganic fractions for dating, the resulting age does not reflect the real age of the sample but is a measure of sample contamination through exchange" (R.P. Beukens, p.c. to G. Matile, 23/09/1986). Sources: G. Matile, p.c. to R. McNeely, 1998.

TO-313 (V1932), mammoth tusk apatite (3880 mg), *Mammuthus* sp. (110 g), from sand and gravel pit in Birds Hill esker, redeposited, presumably from mid-Wisconsinan sediments, about 20 m depth, collected 1986, submitted by G. Matile

normalized age:	940 ± 70
	$\delta^{13}C$= ?‰

Significance: Palaeobiology, anomalous, young

DlLg-1, Paddon: just north of Winnipeg, in East St. Paul, Manitoba (NTS 62 H/14). The site is stratified with Blackduck pottery in the upper levels, and it has been eroded by the river. S-588 is from a bison kill associated with a Larter tanged point. GaK-2746, from the Blackduck levels, was too small to be dated. Sources: S-VII; Mori, 1980; Wilmeth, 1978.

S-588 (CMC-385), bone collagen, from feature 11, units 0, 1, and annex, 105-120 cm depth, collected 1969.06.11, submitted by J. Mori

normalized age:	3075 ± 105
	$\delta^{13}C$= -20‰e
uncorrected age:	2995 ± 105

Significance: Archaic, Pelican Lake

DlLg-32: on the north side of the confluence of the Red and Assiniboine Rivers, 225.6 m asl, Winnipeg, Manitoba (NTS 62 H/14). Sources: Quaternary Consultants Ltd., 1996.

BGS-1839, charcoal, from charred wooden stake immediately adjacent to cremation interment, 1.9 m below AD 1885 soil horizon, burned to ground level by cremation fire, collected 1995, submitted by Quaternary Consultants Ltd.

normalized age:	1370 ± 70
	$\delta^{13}C$= -25‰e
uncorrected age:	1370 ± 70

Significance: Cultural affiliation unknown

BGS-1838, charcoal, from immediately above cremation interment, 1.9 m below AD 1885 soil horizon, collected 1995, submitted by Quaternary Consultants Ltd.

normalized age:	1510 ± 70
	$\delta^{13}C$= -25‰e
uncorrected age:	1510 ± 70

Significance: Cultural affiliation unknown

DlLg-33, The Forks: on the north side of the confluence of the Red and Assiniboine Rivers, Winnipeg, Manitoba (NTS 62 H/14). Sources: L.D. Arnold, letter to P. Priess, 89.05.04, forwarded to E. Nielsen, R. McNeely, and R.E. Morlan; Ebell, 1988; Kroker, 1989; Kroker and Goundry, 1990, 1993; Nicholson, 1996; Quaternary Consultants Ltd., 1990.

BGS-1375, mammal bone collagen, from cultural horizon, 2.6 m depth, 50 m east of BGS-1316, collected 1988, submitted by Quaternary Consultants Ltd.

normalized age:	420 ± 75
	$\delta^{13}C$= -20‰e
uncorrected age:	340 ± 70

Significance: Cultural affiliation unknown, anomalous, young

AECV-792 C, charcoal (9 g), from hearth in clay-silt, unit 21K41H, 50 cm below railway fill, collected 1988.10.14, submitted by P. Priess

normalized age:	500 ± 100
	$\delta^{13}C$= -24.2‰

Significance: Cultural affiliation unknown

BGS-1460, bone collagen, from cultural horizon, 1.1 m depth, collected 1990, submitted by Quaternary Consultants Ltd.

normalized age:	600 ± 70
	$\delta^{13}C$= -23.6‰
uncorrected age:	580 ± 70

Significance: Woodland, Blackduck

BGS-1373, bone collagen, from cultural horizon, 2.28 m depth, in a stratum immediately below BGS-1372, collected 1988, submitted by Quaternary Consultants Ltd.

normalized age:	650 ± 90
	$\delta^{13}C$= -23.6‰
uncorrected age:	630 ± 90

Significance: Late Woodland

BGS-1372, bone collagen, from cultural horizon, 2.2 m depth, collected 1988, submitted by Quaternary Consultants Ltd.

normalized age: 695 ± 100
$\delta^{13}C$= -23.6‰
uncorrected age: 675 ± 100

Significance: Woodland, Blackduck

BGS-1377, bison bone collagen, *Bison* sp., from base of a thick sand layer deposited by a major flood, 0.95 m below the base of the railroad cinder layer, collected 1989, submitted by Quaternary Consultants Ltd.

normalized age: 820 ± 100
$\delta^{13}C$= -20‰e
uncorrected age: 740 ± 100

Significance: Geoarchaeology

BGS-1371, charcoal, from hearth in cultural horizon, 1.7 m depth, collected 1988, submitted by Quaternary Consultants Ltd.

normalized age: 910 ± 70
$\delta^{13}C$= -22.5‰
uncorrected age: 870 ± 70

Significance: Late Woodland

AECV-775 C, charcoal (32 g), from hearth in bedded clay and silt, unit 21K17E, 1.3 m below railway fill, collected 1988.09.08, submitted by P. Priess

normalized age: 980 ± 160
$\delta^{13}C$= -25.4‰

Significance: Cultural affiliation unknown

S-2565, charcoal, from clay, Unit 21K3H19, Level 1 (lowest level), with Blackduck body sherds, a Knife River Flint uniface, and fish scales and bones, collected 1984.09.25, submitted by B. Ebell

normalized age: 1105 ± 160
$\delta^{13}C$= -25‰e
uncorrected age: 1105 ± 160

Significance: Woodland, Blackduck

AECV-777 C, charcoal (36 g), from black organic silt, unit 21K21G, 1.7 m below railway fill, collected 1988.09.28, submitted by P. Priess

normalized age: 1120 ± 150
$\delta^{13}C$= -25.4‰

Significance: Cultural affiliation unknown

AECV-787 C, charcoal (100 g), from hearth in clay-silt, unit 21K35D, 1 m below railway fill, collected 1988.08.05, submitted by P. Priess

normalized age: 1130 ± 110
$\delta^{13}C$= -23.6‰

Significance: Cultural affiliation unknown

AECV-779 C, charred wood (40 g), from fire pit in organic soil, unit 21K23D, >1 m below railway fill, collected 1988.09.23, submitted by P. Priess

normalized age: 1190 ± 130
$\delta^{13}C$= -23.9‰

Significance: Cultural affiliation unknown

AECV-776 C, charcoal (26 g), from hearth on oxidized sand and silt, unit 21K21G, 1.4 m below railway fill, collected 1988.09.13, submitted by P. Priess

normalized age: 1220 ± 150
$\delta^{13}C$= -23.9‰

Significance: Cultural affiliation unknown

AECV-774 C, charcoal (68 g), from sand and clay-silt lens, 4 cm thick, unit 21K16F, 1.3 m below railway fill, collected 1988.09.13, submitted by P. Priess

normalized age: 1220 ± 130
$\delta^{13}C$= -22.1‰

Significance: Cultural affiliation unknown

S-2563, charcoal, from clay-silt, Unit 21K3L, Level 8, hearth associated with Blackduck ceramic rims and body sherds, lithic flakes, and faunal remains, collected 1984.09.25, submitted by B. Ebell

normalized age: 1225 ± 160
$\delta^{13}C$= -25‰e
uncorrected age: 1225 ± 160

Significance: Woodland, Blackduck

AECV-789 C, charcoal (9.5 g), from hearth in clay-silt, units 21K36D, 21K37D, 1 m below railway fill, collected 1988.09.01, submitted by P. Priess

normalized age: 1250 ± 140
$\delta^{13}C$= -23.5‰

Significance: Cultural affiliation unknown

AECV-778 C, charcoal (37 g), from fire pit in silt and sand, unit 21K23D, >1 m below railway fill, collected 1988.09.20, submitted by P. Priess

normalized age: 1250 ± 170
$\delta^{13}C$= -24.5‰

Significance: Cultural affiliation unknown

AECV-791 C, charcoal (38.5 g), from hearth in silt-sand, units 21K38G, 21K39G, 1.3 m below railway fill, collected 1988.09.22, submitted by P. Priess

normalized age: 1250 ± 100
$\delta^{13}C$= -23.9‰

Significance: Cultural affiliation unknown

AECV-784 C, charcoal (25.5 g), from hearth in clay-silt, units 21K27F and 21K28F, 1.7 m below railway fill, collected 1988.10.06, submitted by P. Priess

normalized age: 1280 ± 100
$\delta^{13}C$= -24.8‰

Significance: Cultural affiliation unknown

AECV-782 C, charcoal (27.5 g), from pit feature in organic silt, unit 21K25D, >1 m below railway fill, collected 1988.10.11, submitted by P. Priess

normalized age: 1300 ± 400
$\delta^{13}C$= -25.8‰

Significance: Cultural affiliation unknown

AECV-788 C, charcoal (103 g), from hearth in organic silt, units 21K35D, 21K36D, 1.1 m below railway fill, collected 1988.09.26, submitted by P. Priess

normalized age: 1350 ± 90
$\delta^{13}C$= -24.2‰

Significance: Cultural affiliation unknown

S-2564, charcoal, from clay-silt, Unit 21K3N15, Level 8, collected 1984.10.11, submitted by B. Ebell

normalized age: 1440 ± 165
$\delta^{13}C$= -25‰e
uncorrected age: 1440 ± 165

Significance: Woodland, Blackduck

AECV-783 C, charcoal (32 g), from organic black silt, unit 21K25G, 1.85 m below railway fill, collected 1988.09.27, submitted by P. Priess

normalized age: 1560 ± 100
$\delta^{13}C$= -22.5‰

Significance: Cultural affiliation unknown

BGS-1376, bone collagen, from cultural horizon, 3.2 m depth, collected 1988, submitted by Quaternary Consultants Ltd.

normalized age: 1900 ± 80
$\delta^{13}C$= -20‰e
uncorrected age: 1820 ± 80

Note: Probable contamination with coal dust through a frost crack from the surface.

Significance: Woodland, Blackduck, anomalous, old

BGS-1479, large mammal bone collagen, from cultural horizon, Unit 15, 1.3 m below sand horizon with BGS-1377, collected 1990, submitted by Quaternary Consultants Ltd.

normalized age: 2240 ± 100
$\delta^{13}C$= -20‰e
uncorrected age: 2160 ± 100

Significance: Cultural affiliation unknown

BGS-1370, charcoal, from hearth in cultural horizon, 2.6 m depth, collected 1988, submitted by Quaternary Consultants Ltd.

normalized age: 2330 ± 70
$\delta^{13}C$= -25‰e
uncorrected age: 2330 ± 70

Significance: Cultural affiliation unknown

BGS-1480, large mammal bone collagen, from cultural horizon, Unit 20, 1.3 m below sand horizon with BGS-1377, same horizon as BGS-1479, collected 1990, submitted by Quaternary Consultants Ltd.

normalized age: 2420 ± 90
$\delta^{13}C$= -20‰e
uncorrected age: 2340 ± 90

Significance: Cultural affiliation unknown

BGS-1316, charcoal, from cultural horizon, 2.85 m depth, collected 1988, submitted by Quaternary Consultants Ltd.

normalized age: 2870 ± 80
$\delta^{13}C$= -25‰e
uncorrected age: 2870 ± 80

Significance: Archaic, unspecified

BGS-1483, mammal bone collagen, from cultural horizon, Unit 5, 3.0 m depth, same horizon as BGS-1484, collected 1990, submitted by Quaternary Consultants Ltd.

normalized age: 2895 ± 80
$\delta^{13}C$= -20‰e
uncorrected age: 2815 ± 75

Significance: Cultural affiliation unknown

BGS-1374, large mammal bone collagen, from cultural horizon, 3.2 m depth, 100 m east of BGS-1316, collected 1988, submitted by Quaternary Consultants Ltd.

normalized age: 2930 ± 90
$\delta^{13}C$= -20‰e
uncorrected age: 2850 ± 90

Significance: Cultural affiliation unknown

BGS-1482, bone collagen, from cultural horizon, Unit 7, 3.0 m depth, same horizon as BGS-1481, collected 1990, submitted by Quaternary Consultants Ltd.

normalized age: 2930 ± 80
$\delta^{13}C$= -20‰e
uncorrected age: 2850 ± 75

Significance: Cultural affiliation unknown

BGS-1481, bone collagen, from cultural horizon, Unit 1, 3.0 m depth, same horizon as BGS-1482, collected 1990, submitted by Quaternary Consultants Ltd.

normalized age: 3070 ± 80
$\delta^{13}C$= -20‰e
uncorrected age: 2990 ± 80

Significance: Cultural affiliation unknown

BGS-1484, fish bone collagen, from cultural horizon, Unit 14, 3.0 m depth, same horizon as BGS-1483, collected 1990, submitted by Quaternary Consultants Ltd.

normalized age:	3595 ± 80
	$\delta^{13}C$= -20‰e
uncorrected age:	3515 ± 75

Significance: Cultural affiliation unknown, anomalous, old

BGS-1315, charcoal, from cultural horizon, 2.85 m depth, collected 1988, submitted by Quaternary Consultants Ltd.

normalized age:	16 330 ± 200
	$\delta^{13}C$= -25‰e
uncorrected age:	16 330 ± 200

Note: Probable contamination with coal dust through a frost crack from the surface.

Significance: Archaic, unspecified, anomalous, old

DlLg-VP1, St. Boniface Hospital: at the pumping station of the St. Boniface Hospital, Winnipeg, Manitoba. This sample was submitted by E. Nielsen to gain information on fluvial processes and alluviation along Red River, particularly to determine the sedimentation pattern. The dated wood was associated with bison bones. Sources: this report.

BGS-1422, wood from clay overlain by 7 m of Red River alluvium, collected 1990, submitted by E. Nielsen

normalized age:	1380 ± 80
	$\delta^{13}C$= -25‰e
uncorrected age:	1380 ± 80

Significance: palaeobiology

DlLg-VP2, Bottomly Creek: right (east) bank of the Red River, just northeast of the city of Winnipeg, near the mouth of Bottomly Creek, Manitoba (NTS 62 H/14). Five sections were examined along a 200 m exposure just upstream from the creek mouth. Bison bones from sections B and E were submitted for radiocarbon dating. A small piece of aboriginal pottery was recorded at a depth of 15 cm in section B, 75 cm above the bones dated by BGS-925. Sources: Nielsen et al., 1993.

BGS-925, bison bone collagen, *Bison* sp., from section B, 0.9 m depth, in silty clay beneath three palaeosols, submitted by E. Nielsen

normalized age:	2450 ± 100
	$\delta^{13}C$= -20‰e
uncorrected age:	2370 ± 100

Significance: Palaeobiology

BGS-924, bison bone collagen, *Bison* sp., from section E, 1.3 m depth, in silty clay beneath two palaeosols, submitted by E. Nielsen

normalized age:	4620 ± 100
	$\delta^{13}C$= -20‰e
uncorrected age:	4540 ± 100

Significance: Palaeobiology

DlLh-1, St. James Mound: in St. James-Assiniboia, Winnipeg, Manitoba (NTS 62 H/14). I-4684 agrees with the age implied by artifact typology and indicates that mound building in Manitoba continued into early historic times. Sources: I-IX; Mori, 1980; Wilmeth, 1978.

I-4684, wood, from pole near bottom of central burial pit, collected 1969, submitted by R.J. Nash

normalized age:	220 ± 90
	$\delta^{13}C$= -25‰e
uncorrected age:	220 ± 90

Significance: Protohistoric

DlLh-VP1: on a terrace on the south side of Assiniboine River and Truro Creek in Bruce Park, 232 m asl, west end of Winnipeg, Manitoba (NTS 62 H/14). Comment (E. Nielsen): Natural river cut where Truro Creek joins Assiniboine River in west end of Winnipeg. Sample was excavated from dry compact silt. No mold or plant growth. Date of sample will help establish timing of occupation of Assiniboine River. Estimated age about 2 ka BP. Rannie et al. suggest the river drained into Lake Manitoba between 7.5 and 3.0 ka BP. Previous date of 7500 ± 80 (GSC-4839) suggests river occupied the present course in early Holocene. Sources: Nielsen et al., 1993; Rannie et al., 1989.

BGS-1410 (IN-86-1), bison bone collagen, *Bison* sp., from alluvial silt in a natural river cut, 2.0 m depth, collected 1986, submitted by E. Nielsen

normalized age:	405 ± 100
	$\delta^{13}C$= -20‰e
uncorrected age:	325 ± 100

Significance: Palaeobiology

DlLh-VP2, Ruby Street: on the Assiniboine River terrace, 221 m asl, near the corner of Ruby Street and Palmerston Avenue, Winnipeg, Manitoba (NTS 62 H/14). About 0.3 m of homogeneous stiff blue clay was overlain by pea gravel and cross-bedded sand containing numerous articulated freshwater clams, pieces of wood, and parts of a bison skeleton. The sand was overlain by very fine laminated silty clay of undetermined thickness. The clay at the base of the sequence was probably deposited in Lake Agassiz, and the overlying sand, gravel and silt is probably a point bar deposit associated with the formation of the Assiniboine River terrace. Sources: GSC-XXXI; Nielsen et al., 1993, 1996.

GSC-4839, wood, deciduous (id. by H. Jetté), from clay exposed in a sewer excavation, 10.7 m depth, beneath fluvial sediments containing bison bones, collected 1969, submitted by E. Nielsen

normalized age:	7500 ± 80
	$\delta^{13}C$= -24.6‰
uncorrected age:	7490 ± 80

Significance: Palaeobiology, maximum age

DlLi-10, Kuypers: south bank of the Assiniboine River, 1.8 km west of the perimeter highway, just west of Winnipeg, Manitoba (NTS 62 H/14). This site was excavated by a University of Winnipeg crew in 1980. Sources: Nielsen et al., 1996; E. Nielsen, p.c. 1998.

BGS-1825, bone collagen (from 76.8 g), from alluvium, 30-35 cm depth, collected 1980, submitted by E. Nielsen

normalized age: 4030 ± 120
$\delta^{13}C$= -20‰e
uncorrected age: 3950 ± 120

Significance: Archaic, Oxbow

DlLj-VP: Assiniboine River, 26 km west of junction with Red River, Manitoba (NTS 62 H/14).

Comment (E. Nielsen): Bison bones from well drained silt in recent natural river exposure. No obvious plant growth. Sample will help determine sedimentation rate along Assiniboine River and date occupation of modern river in this valley. Age <1000 years. Sources: E. Nielsen, p.c. 1998; Rannie et al., 1989.

BGS-1436, bison bone collagen, *Bison* sp. (225 g), from highly calcareous alluvial silt in a natural river exposure, 1.4-1.6 m depth in a section about 4 m high, collected 1990, submitted by E. Nielsen

normalized age: 655 ± 75
$\delta^{13}C$= -20‰e
uncorrected age: 575 ± 70

Significance: Palaeobiology

DlLt-VP, Carberry: roadcut through a stabilized dune in the Brandon Sand Hills, northeast of Carberry, Manitoba (NTS 62 G/14). In addition to GSC-990 on bison bones, GSC-931 consisted of bulk soil from the upper of the two palaeosols observed at this site. The normalized age, 1200 ± 140 BP, is in close agreement with the bone date. Sources: GSC-XI.

GSC-990, bison bone collagen, *Bison* sp. 3 vertebrae (357 g; id. by C.R. Harington), from dune sand with reworked humus overlying the upper of two palaeosols, collected 1967, submitted by P.P. David

normalized age: 1260 ± 130
$\delta^{13}C$= -19.1‰
uncorrected age: 1170 ± 130

Significance: Palaeobiology

DlLw-11, Kain: on an alluvial terrace, 358 m asl, on the south bank of Willow Creek which enters Assiniboine River 1 km south of Chater, Manitoba (NTS 62 G/13). Sources: SFU-II; Nicholson, 1985b, 1994a, 1994b.

SFU-75, bone collagen, from topsoil, 0-30 cm depth, collected 1983.07.19, submitted by B.A. Nicholson

normalized age: 310 ± 100
$\delta^{13}C$= -18.8‰

Note: Nicholson 1994a quotes this date as 290 ± 100

Significance: Woodland, unspecified

SFU-72, bone collagen, from paleosol in alluvium, 30-50 cm depth, collected 1983.07.19, submitted by B.A. Nicholson

normalized age: 1700 ± 100
$\delta^{13}C$= -18.8‰

Significance: Woodland, Besant

S-2827, bison bone collagen, *Bison* sp., from paleosol in alluvium, 50-80 cm depth, collected 1986.05.21, submitted by B.A. Nicholson

normalized age: 2145 ± 105
$\delta^{13}C$= -20‰e
uncorrected age: 2065 ± 105

Significance:Archaic, Pelican Lake

S-2903, bone collagen, from paleosol in alluvium, >110 cm depth, submitted by B.A. Nicholson

normalized age: 4135 ± 155
$\delta^{13}C$= -20‰e
uncorrected age: 4055 ± 155

Significance:Archaic, unspecified

DlLw-12, Kain Cache: on the south bank of Willow Creek, 366 m asl, tributary to Assiniboine River, southwestern Manitoba (NTS 62 G/13). It is a meat cache with a stone covering. Sources: SFU-II; Nicholson, 1985a.

SFU-73, bone collagen, from soil matrix 0-10 cm beneath a rock cairn, collected 1981.07.29, submitted by B.A. Nicholson

normalized age: 480 ± 100
$\delta^{13}C$= -17.9‰

Significance: Cultural affiliation unknown

DlLx-3: on the grounds of the Mental Hospital in Brandon, Assiniboine River, Manitoba (NTS 62 G/13). Only bones and stone flakes were found with this sample. Sources: SFU-II; B.A. Nicholson, p.c. 1998.

SFU-74, bone collagen, from lower terrace, submitted by B.A. Nicholson

normalized age: 1780 ± 100
$\delta^{13}C$= -18.8‰

Significance: Cultural affiliation unknown

DgMb-VP: on the northern flank of Turtle Mountain, 590 m asl, 22 km southwest of Boissevain and 19 km southeast of Deloraine, Manitoba (NTS 62 F/01).

Comment by R.J. Fulton: The tusk piece was recovered during gravel pit operations. It was assumed to have come from a sub-till gravel. The age is a minimum for the last ice sheet advance into this area, but probably predates this event by at least 10 ka. Sources: Fulton, 1995.

TO-4639 (FI-94-0037), mammoth tusk collagen, *Mammuthus* sp., from gravel in a gravel pit, presumably from beneath till, collected 1991, submitted by R.J. Fulton

normalized age: 33 860 ± 330
$\delta^{13}C$= ?‰

Significance: Palaeobiology

DgMg-2, Mound G: south of Melita, on the right bank of Gainsborough Creek, Souris River valley, Manitoba (NTS 62 F/03). Wood from a southern Manitoba mound was excavated by W.B. Nickerson in 1913 and 1914. Samples now at the Canadian Museum of Civilization were described by Capes (1963) and assigned to the Blackduck (Manitoba) focus by MacNeish (1954) or to "closely related peoples influenced by accumulated traits that reach back to Middle Woodland times" (Capes, 1963). Suggested dates are late prehistoric and early historic. Wood samples associated with three of Nickerson's mounds were submitted by R. Wilmeth in 1968 to test this conclusion.

Wilmeth summarized the characteristics of Mound G: Mound 20" high and 33-39 ft in diameter. Untrimmed branches laid under mound. No primary internment, center disturbed. Fragment of human skull at depth of 2 ft. Small walled oblong rectangle attached to southeast of mound. See Capes (1963: 15-16, Fig. 7).

Comment by Wilmeth on dates from Mound G, Heath Mound and Riverview Mound: date range indicates that the mounds were built over a longer period than originally thought. Two later dates (GaK-1881, -1882) are within Blackduck focus time range, but earliest date (GaK-1883) falls during the transition from Middle to Late Woodland. In view of the age of similar mounds in North and South Dakota (Neuman, 1967), the southern Manitoba mounds may represent a cultural tradition surviving from Middle Woodland to Historic times. Sources: GaK-VIII; Capes, 1963; Wilmeth, 1978.

GaK-1881 (CMC-291), wood, from burial pole, base of mound, 50 cm long, 10-11 cm diameter, collected 1913.08, submitted by R. Wilmeth

normalized age: 390 ± 90
$\delta^{13}C$= -25‰e
uncorrected age: 390 ± 90

Significance: Woodland, Blackduck

DgMg-15, Snyder II: on the plain overlooking the confluence of Gainsborough Creek and Souris River, 450 m asl, southwestern Manitoba (NTS 62 F/03). It is located in the same field as Mounds A, B, C, and D (Capes, 1963), but a relationship to the mounds has not yet been demonstrated. Syms (1974) distinguished 15 stratigraphic zones within a bell-shaped pit and noted changes in activities reflected by their artifact content. Zones 9-15, the lower zones, contain two distinct hearths and several scattered ash concentrations in heterogeneous gravel, loam and refuse; tools are rare. Zones 3-7 consist of closely stratified, alternating hearths and gravel lenses, the hearths containing numerous artifacts and bison bones. Zones 1 and 2 contain a few sherds and lithics around the pit periphery. The only vessel represented by any large number of sherds is scattered throughout the pit. This is the justification for listing all finds in a single record in this data base, including the radiocarbon sample (Zone 15), the canid remains (Zones 11-15), and the bison bones (Zones 3 and 5). Sources: GSC-XII; Syms, 1974; Wilmeth, 1978.

GSC-1546 (CMC-463), charcoal, from Zone 15, Sq. VII, lowest hearth on floor of bell-shaped pit, collected 1970.08.05, submitted by E.L. Syms

normalized age: 340 ± 130
$\delta^{13}C$= -25‰e
uncorrected age: 340 ± 130

Significance: Woodland, Middle Missouri

DgMg-137, Heath Mound: south of Melita, on the right bank of the Souris River, Manitoba (NTS 62 F/03). Wood from a southern Manitoba mound was excavated by W.B. Nickerson in 1913 and 1914. Samples now at the Canadian Museum of Civilization were described by Capes (1963) and assigned to the Blackduck (Manitoba) focus by MacNeish (1954) or to "closely related peoples influenced by accumulated traits that reach back to Middle Woodland times" (Capes, 1963). Suggested dates are late prehistoric and early historic. Wood samples associated with three of Nickerson's mounds were submitted by R. Wilmeth in 1968 to test this conclusion.

Wilmeth summarized characteristics of Heath Mound: Low broad mound, 18" high, 46 x 42 ft in diameter. Fifteen foot burned earth ring within mound, with burned poles below. Suggests mud-plastered hut destroyed by fire, mound built over ruin. Few artifacts found. See Capes (1963: 39-41).

Comment by Wilmeth on dates from Mound G, Heath Mound, and Riverview Mound: date range indicates that the mounds were built over a longer period than originally thought. Two later dates (GaK-1881, -1882) are within Blackduck focus time range, but earliest date (GaK-1883) falls during the transition from Middle to Late Woodland. In view of the age of similar mounds in North and South Dakota (Neuman, 1967), the southern Manitoba mounds may represent a cultural tradition surviving from Middle Woodland to Historic times. Sources: GaK-VIII; Capes, 1963; Wilmeth, 1978.

GaK-1882 (CMC-292), wood, from 1.5 m northwest of mound centre, driven into subsurface 15-20 cm, collected 1914.07, submitted by R. Wilmeth

normalized age: 850 ± 90
$\delta^{13}C$= -25‰e
uncorrected age: 850 ± 90

Note: This sample is identified incorrectly as S-690 in Syms (1978: 67).

Significance: Woodland, Blackduck

DgMg-162, Charcoal: on the plain above Gainsborough Creek, 16 km southwest of Melita, southwestern Manitoba (NTS 62 F/03). Sources: Nicholson, 1994b; Nicholson and Malainey, 1994.

S-3458, charcoal, from Feature 3, hearth, Unit 3, Block B, submitted by B.A. Nicholson

normalized age: 220 ± 100
$\delta^{13}C$= -25‰e
uncorrected age: 220 ± 100

Significance: Cultural affiliation unknown

DgMh-48, Feland: near Antler River, southwestern Manitoba (NTS 62 F/03). It is possibly related to the Devils Lake-Sourisford burial complex, representing the terminal age range. Sources: S-IX; Syms, 1977, 1979a, p.c. 1998.

S-686, mammal bone collagen, from a single, thin, buried soil horizon ca. 13-15 cm depth, collected 1971, submitted by E.L. Syms

normalized age:	580 ± 130
	$\delta^{13}C$= -20‰e
uncorrected age:	500 ± 130

Significance: Late Woodland, unspecified

DhMg-7, Brockinton: south of Melita, 435 m asl, on an east bank floodplain of the Souris River, Manitoba (NTS 62 F/03). This is a multicomponent site with three Late Woodland occupations. Syms reports, in Wilmeth (1978: 108-109), the following characteristics: Occupation 1 is 7 m long, a concentration of bison bone from animals butchered at the edge of a meander of the Souris River. Artifacts consist of numerous small and medium-sized points with shallow rounded side-notched and square bases, apparently similar to points found in later occupations with Late Woodland ceramics. Samples will also give an indication of the time of a climatic shift which made the Souris flood plain a favoured habitation zone, since sites appear to correlate with a soil change extending for many miles along the river bank. Occupation 2 is a bone concentration marking a broad butchering area along a meander of Souris River. Artifacts were sparse, primarily a few side-notched points which are post-Avonlea but do not fit into the Prairie side-notched dichotomy. GaK-3806 will indicate the time of most severe flooding since the site was first occupied, as apparently represented by the sand stratum. Occupation 3 includes an early ceramic industry unlike that recorded in other parts of Manitoba, or in Minnesota and the Dakotas, with straight-based side-notched and elongate triangular points. One piece of catlinite tube was found. GaK-3807 will date a ceramic industry which cannot otherwise be assigned chronologically, and will represent the first dated ceramic component from southwestern Manitoba.

Syms comments that the modern date for GaK-3807 is unacceptable. Different dates for GaK-3805 apatite and GaK-3805 collagen reflect some of the problems with the use of different techniques on bone. GaK-3805 collagen is likely to be the better date, on the basis of GaK-3806, since found to be redeposited bone from Occupation 1. Syms comments (in S-IX: 97): part of a series of 9 dates from 3 labs; in two cases, samples were divided for alternate fraction dating. S-687 dates generally agree with apatite date of GaK-3805a but differ from acid residue date of GaK-3805b and collagen date of GaK-3806 from same occupation. S-688 unacceptable for strata position. S-689 agrees with alkali insoluble fraction date (A-1206a) but not humate fraction (A-1206b). Sources: A-X, S-IX; Long and Tamplin, 1977; Wilmeth, 1978.

GaK-3805 (CMC-459), bone collagen, from dark gray clayey silt, Level 10, lowest occupation level, collected 1970.08.22, submitted by E.L. Syms

normalized age:	710 ± 300
	$\delta^{13}C$= -20‰e
uncorrected age:	630 ± 300

Note: Apatite fraction, 1260 ± 130 BP (normalized to 1505 ± 135 BP).

Significance: Woodland, unspecified

S-687, bison bone collagen, *Bison* sp., from dark gray clayey silt, Level 10, lowest occupation level, collected 1971, submitted by E.L. Syms

normalized age:	1400 ± 100
	$\delta^{13}C$= -20‰e
uncorrected age:	1320 ± 100

Note: This is a re-run. The original measurement was 1110 ± 80 BP (normalized, 1190 ± 85 BP).

Significance: Woodland, unspecified

GaK-3806 (CMC-461), bone collagen, from coarse yellow sand overlying clayey silt, Level 9, collected 1970.08.21, submitted by E.L. Syms

normalized age:	590 ± 80
	$\delta^{13}C$= -20‰e
uncorrected age:	510 ± 80

Significance: Woodland, unspecified

S-688, bison bone collagen, *Bison* sp., from coarse yellow sand overlying clayey silt, Level 9, collected 1971, submitted by E.L. Syms

normalized age:	1510 ± 80
	$\delta^{13}C$= -20‰e
uncorrected age:	1430 ± 80

Significance: Woodland, unspecified

GaK-3807 (CMC-462), bone collagen, from dark gray sandy silt, Level 6, Sq. D, collected 1970.08.18, submitted by E.L. Syms

normalized age:	0 ± 650
	$\delta^{13}C$= -20‰e
uncorrected age:	0 ± 650

Significance: Woodland, unspecified, anomalous, young

A-1206, charcoal, from latest of three occupation levels, Sq. D, Levels 3 and 5, 27 cm depth, collected 1971, submitted by M. Tamplin

normalized age:	290 ± 120
	$\delta^{13}C$= -24.9‰
uncorrected age:	290 ± 120

Note: Alkali insoluble fraction. Humate fraction, 1240 ± 70 BP (normalized), suspected of lab contamination when the tube broke with the sample in it.

Significance: Woodland, unspecified

S-689, bison bone collagen, *Bison* sp., from dark gray sandy silt, Level 6, collected 1971, submitted by E.L. Syms

normalized age:	430 ± 130
	$\delta^{13}C$= -20‰e
uncorrected age:	350 ± 130

Significance: Woodland, unspecified

DhMg-37, Snyder Dam: near the confluence of Gainsborough Creek and Souris River, south of Melita, Manitoba (NTS 62 F/02). It contains stratigraphically separated components yielding late Middle Woodland and Late Woodland ceramics. S-683 found in and on top of ash lens, associated with cultural material, fragments of a thick crude Woodland vessel, a small shallow side-notched point, and six flakes of Knife River flint. Vessel resembles Flanders Crockery Creek ceramics from south-central Michigan and somewhat like Canteen cordmarked ware. First date from western Canada with this type of pottery.

Comment by E.L. Syms: S-683 is satisfactory, although slightly early. S-741 on charcoal and S-739 on bone, from same occupation, cluster fairly closely. Range of AD 880 to 1000 assigned to this component based on charcoal date and because the two bone dates overlap either end of this range. See Syms (1979b: 54-56) for a detailed discussion of these dates. Sources: S-VII, S-IX; Syms, 1979b; Wilmeth, 1978.

S-739 (73-1), bone collagen, from hearth in river bank, 122 cm depth, collected 1971, submitted by E.L. Syms

normalized age:	1010 ± 75
	$\delta^{13}C$= -20‰e
uncorrected age:	930 ± 70

Significance: Woodland, unspecified

S-741 (73-3), charcoal, from hearth in river bank, 122 cm depth, collected 1971, submitted by E.L. Syms

normalized age:	1010 ± 60
	$\delta^{13}C$= -25‰e
uncorrected age:	1010 ± 60

Significance: Woodland, unspecified

S-683 (CMC-470), bone collagen, from the lower of two hearths in river bank, 122 cm depth, collected 1970.09, submitted by E.L. Syms

normalized age:	1200 ± 80
	$\delta^{13}C$= -20‰e
uncorrected age:	1120 ± 75

Significance: Woodland, unspecified

S-740 (73-2), charcoal, from hearth in river bank, 107-112 cm depth, collected 1971, submitted by E.L. Syms

normalized age:	670 ± 70
	$\delta^{13}C$= -25‰e
uncorrected age:	670 ± 70

Significance: Woodland, unspecified

DhMg-39, Riverview Mound: south of Melita along the Souris River, Manitoba (NTS 62 F/03). Wood from a southern Manitoba mound was excavated by W.B. Nickerson in 1913 and 1914. Samples now at the Canadian Museum of Civilization were described by Capes (1963) and assigned to the Blackduck (Manitoba) focus by MacNeish (1954) or to "closely related peoples influenced by accumulated traits that reach back to Middle Woodland times" (Capes, 1963). Suggested dates are late prehistoric and early historic. Wood samples associated with three of Nickerson's mounds were submitted by R. Wilmeth in 1968 to test this conclusion.

Wilmeth summarized characteristics of Riverview Mound: small dome-shaped mound, 2.5 ft high, 41 x 35 ft in diameter. Burial pit located slightly south of center. Several burials apparently in pit. Scattered human bones stained with red ochre.

Comment by Wilmeth on dates from Mound G, Heath Mound, and Riverview Mound: date range indicates that the mounds were built over a longer period than originally thought. Two later dates (GaK-1881, -1882) are within Blackduck focus time range, but earliest date (GaK-1883) falls during the transition from Middle to Late Woodland. In view of the age of similar mounds in North and South Dakota (Neuman, 1967), the southern Manitoba mounds may represent a cultural tradition surviving from Middle Woodland to Historic times. Sources: GaK-VIII; Capes, 1963; Wilmeth, 1978.

GaK-1883 (CMC-293), wood, from covering of burial pit, excavated into subsoil to 77 cm depth, collected 1913.10.04, submitted by R. Wilmeth

normalized age:	1330 ± 90
	$\delta^{13}C$= -25‰e
uncorrected age:	1330 ± 90

Significance: Cultural affiliation unknown

DiMd-7, Mullett: on the north bank of the Souris River, west of Hartney, southwestern Manitoba (NTS 62 F/07). Sources: Nicholson, 1988, 1994b.

S-2825, bison bone collagen, *Bison* sp., from soil/till, bone bed, collected 1986.08.14, submitted by B.A. Nicholson

normalized age:	1310 ± 100
	$\delta^{13}C$= -20‰e
uncorrected age:	1230 ± 100

Significance: Woodland, Besant

S-2826, bison bone collagen, *Bison* sp., from soil/till, bone bed, collected 1986.08.14, submitted by B.A. Nicholson

normalized age:	1390 ± 100
	$\delta^{13}C$= -20‰e
uncorrected age:	1310 ± 100

Significance: Woodland, Besant

DiMe-16, Duthie: on a delta sand plain, among stabilized low sand dunes northeast of Lauder, in the Souris drainage, Manitoba (NTS 62 F/07). Sources: Nicholson, 1994b, 1996, p.c. 1998.

S-3501, bone collagen, from unreported provenience, submitted by B.A. Nicholson

normalized age:	650 ± 270
	$\delta^{13}C$= -20‰e
uncorrected age:	570 ± 270

Note: Revised from original report of 4370 ± 220; date is rejected, because it resulted from recalibration of a sample which was double-diluted at the lab.

Significance: Woodland, Middle Missouri, anomalous, young

Beta-62705, bison bone collagen, *Bison* sp. humerus, from cultural layer, 30 cm depth, submitted by B.A. Nicholson

normalized age: 960 ± 80
$\delta^{13}C$= -20‰e
uncorrected age: 880 ± 80

Significance: Woodland, Middle Missouri

DiMe-17, Jackson: among low, stabilized sand dunes on a delta sand plain northeast of Lauder, Manitoba (NTS 62 F/07). Sources: Nicholson, 1996, p.c. 1998.

Beta-83865, bison bone collagen, *Bison* sp. radius, from cultural layer, 15 cm depth, submitted by B.A. Nicholson

normalized age: 290 ± 50
$\delta^{13}C$= -20‰e

Significance: Woodland, Vickers Focus

Beta-83864, bison bone collagen, *Bison* sp. cervical vertebra, from cultural layer, 10 cm depth, submitted by B.A. Nicholson

normalized age: 300 ± 70
$\delta^{13}C$= -20‰e

Significance: Woodland, Vickers Focus

Beta-82792, bison bone collagen, *Bison* sp. metapodial, from cultural layer, 14 cm depth, submitted by B.A. Nicholson

normalized age: 410 ± 60
$\delta^{13}C$= -20‰e

Significance: Woodland, Vickers Focus

Beta-65952, bison bone collagen, *Bison* sp., from shovel test, 10-40 cm depth, submitted by B.A. Nicholson

normalized age: 620 ± 65
$\delta^{13}C$= -20‰e
uncorrected age: 540 ± 60

Significance: Woodland, Blackduck ?

DiMe-25, Vera: in the Makotchi-Ded Dontipi locale on the southwestern edge of the Lauder Sand Hills, Souris valley, Manitoba (NTS 62 F/07). This is the most complexly stratified site in the locale, with Historic, Vickers Focus, Besant/Samantha, and Duncan/Hanna components. The only reported date pertains to the Vickers Focus. Sources: Nicholson and Hamilton, 1997a, 1997b.

Beta-96109, bone collagen, from cultural layer, submitted by B.A. Nicholson

normalized age: 340 ± 60
$\delta^{13}C$= -20‰e

Significance: Woodland, Vickers Focus

DjMb-16, Good: on the Souris River floodplain, east of Souris, Manitoba (NTS 62 F/09). Sources: Nicholson, 1994b, p.c. 1998.

S-3499, bison bone collagen, *Bison* sp. humerus, from silt exposed in river cut bank, 1 m depth, submitted by B.A. Nicholson

normalized age: 410 ± 140
$\delta^{13}C$= -20‰e
uncorrected age: 330 ± 140

Significance: Woodland, unspecified

DjMd-4, Owti: west of Souris, 427 m asl, southwestern Manitoba (NTS 62 F/10). Sources: Peach and Burton-Coe, 1994.

S-3129, bison bone collagen, *Bison* sp., from silty sand, cultural layer 1, 15 cm depth, collected 1988.07.15, submitted by B.A. Nicholson

normalized age: 430 ± 65
$\delta^{13}C$= -20‰e
uncorrected age: 350 ± 60

Significance: Cultural affiliation unknown

S-3130, bison bone collagen, *Bison* sp., from silty sand, paleosol, cultural layer 2, 90 cm depth, collected 1988.08.15, submitted by B.A. Nicholson

normalized age: 1520 ± 65
$\delta^{13}C$= -20‰e
uncorrected age: 1440 ± 60

Significance: Woodland, Besant

DkMd-3, Gompf: in a tributary ravine of Assiniboine River, western Manitoba (NTS 62 F/15). Three samples are believed to represent a single event. Sources: S-IX; Syms, 1983.

S-1368 (Br-77-4), bison bone collagen, *Bison* sp., from Unit B, Level 3, bottom of bone bed, 20-30 cm depth, collected 1977, submitted by E.L. Syms

normalized age: 1070 ± 75
$\delta^{13}C$= -20‰e
uncorrected age: 990 ± 70

Significance: Woodland, Blackduck

S-1366 (Br-77-2), bison bone collagen, *Bison* sp., from Unit B, Level 3, bottom of bone bed, 20-30 cm depth, collected 1977, submitted by E.L. Syms

normalized age: 1100 ± 65
$\delta^{13}C$= -20‰e
uncorrected age: 1020 ± 60

Significance: Woodland, Blackduck

S-1367 (Br-77-3), bison bone collagen, *Bison* sp., from Unit B, Level 3, bottom of bone bed, 20-30 cm depth, collected 1977, submitted by E.L. Syms

normalized age:	1220 ± 75
	$\delta^{13}C$= -20‰e
uncorrected age:	1140 ± 70

Significance: Woodland, Blackduck

DkMe-10, Cherry Point: at the north end of Oak Lake, 435 m asl, about 20 km southeast of Virden, Manitoba (NTS 62 F/10). Dates on this site are in stratigraphic order, but all are younger than expected from their artifact associations. Sources: S-IX; Balcom, 1976; Haug, 1975, 1976.

S-1033 (Br-1-Ce), bone collagen, from main area, occupation A, the highest occupation beneath the plow zone, collected 1974, submitted by E.L. Syms

normalized age:	1100 ± 110
	$\delta^{13}C$= -20‰e
uncorrected age:	1020 ± 110

Significance: Archaic, Duncan, Hanna

S-1034 (Br-1-Cf), bone collagen, from main area, occupation A, the highest occupation beneath the plow zone, collected 1974, submitted by E.L. Syms

normalized age:	1120 ± 190
	$\delta^{13}C$= -20‰e
uncorrected age:	1040 ± 190

Significance: Archaic, Duncan, Hanna

S-1031 (Br-1-Cb), bone collagen, from main area, occupation B, the middle occupation, collected 1974, submitted by E.L. Syms

normalized age:	1930 ± 100
	$\delta^{13}C$= -20‰e
uncorrected age:	1850 ± 100

Significance: Archaic, Oxbow, Duncan, Hanna

S-1032 (Br-1-Cd), bone collagen, from main area, occupation B, the middle occupation, collected 1974, submitted by E.L. Syms

normalized age:	2140 ± 130
	$\delta^{13}C$= -20‰e
uncorrected age:	2060 ± 130

Significance: Archaic, Oxbow, Duncan, Hanna

S-1030 (Br-1-Ca), bone collagen, from main area, occupation C, the lowest occupation, collected 1974, submitted by E.L. Syms

normalized age:	2910 ± 260
	$\delta^{13}C$= -20‰e
uncorrected age:	2830 ± 260

Significance: Archaic, Oxbow, Duncan, Hanna

S-1029 (Br-1-Cc), bone collagen, from main area, occupation C, the lowest occupation, collected 1974, submitted by E.L. Syms

normalized age:	2940 ± 210
	$\delta^{13}C$= -20‰e
uncorrected age:	2860 ± 210

Significance: Archaic, Oxbow, Duncan, Hanna

DkMg-1, Reston: on a glacial outwash ridge about 200 m south of Pipestone Creek, near Reston, Manitoba (NTS 62 F/11). It is related to the Devils Lake-Sourisford burial complex. Sources: S-IX; Braddell, et al. 1970; Syms, 1979a.

S-743, human bone collagen, *Homo sapiens* long bone fragments, from gravel pit excavation, collected 1969, submitted by E.L. Syms

normalized age:	770 ± 180
	$\delta^{13}C$= -19‰e
uncorrected age:	670 ± 180

Note: The normalized age is a minimum, because bison that had consumed C_4 plants were probably included in the diet.

Significance: Woodland, unspecified

DkMh-1, Stendall: west of Virden, along Pipestone Creek, Manitoba (NTS 62 F/14). It is a multicomponent Late Woodland site containing Blackduck and other undefined materials. Sources: S-VIII, S-IX; Rushowick, 1975; Wilmeth, 1978.

S-785 (CMC-604), bison bone collagen, *Bison*? sp., from Unit 15, Level 2, 5.1-10.2 cm depth, collected 1972.07.20, submitted by W.M. Hlady

normalized age:	835 ± 65
	$\delta^{13}C$= -20‰e
uncorrected age:	755 ± 60

Significance: Woodland, unspecified

S-690, bison bone collagen, *Bison* sp., collected 1972, submitted by E.L. Syms

normalized age:	930 ± 80
	$\delta^{13}C$= -20‰e
uncorrected age:	850 ± 80

Significance: Woodland, unspecified

S-786 (CMC-605), bison bone collagen, *Bison*? sp., from Unit 15, Level 3, 10.2-15.2 cm depth, collected 1972.07.20, submitted by W.M. Hlady

normalized age:	1045 ± 75
	$\delta^{13}C$= -20‰e
uncorrected age:	965 ± 70

Significance: Woodland, unspecified

DlMa-1, Stott: 12 km west of Brandon along the north side of Assiniboine River, Manitoba (NTS 62 F/16). Tisdale (1978: 41) notes: "Cultural materials recovered from Grand Valley Provincial Park in 1977 are more varied than was expected. Data from previous excavations suggested a homogeneous early Late Woodland assemblage. Though a series of Blackduck occupations was suspected, cultural strata have not yet been successfully distinguished within the Stott farm area." GX-5140 was associated with many flakes, smashed bones, cord-roughened body sherds, possibly contaminated by a capping of landscaping fill. GX-5141 was from a hearth with ash extending to Level 7 and most bone and all lithics and ceramics in Levels 4-7; therefore it provides a minimum age on the feature. The date from GX-5143 suggests Late Archaic, but no Archaic diagnostics were found. GX-5174 and GX-5175 were associated with cord-roughened and other sherds, butchered bone, one flake. GX-5176 was associated with cord-roughened body sherds, a simple dentate decorated neck sherd, a chert biface, flakes, and large butchered bones. GX-5177 pre-dates Blackduck pottery found in overlying levels. S-2320 is presented as an Archaic date, but no such diagnostics were found; the sample was associated with pottery. Sources: S-IX, SFU-III; Badertscher, et al. 1987; Tisdale, 1978.

GX-5140, charcoal, from Area A (1977), Unit 5, Level 5, compacted black topsoil, submitted by M.A. Tisdale

normalized age:	355 ± 115
	$\delta^{13}C$= -25‰e
uncorrected age:	355 ± 115

Significance: Woodland, unspecified

GX-5141 G, bone collagen, from Area A (1977), Unit 16, Level 3, remnants of a hearth, submitted by M.A. Tisdale

normalized age:	715 ± 140
	$\delta^{13}C$= ?‰
uncorrected age:	590 ± 140

Note: GX-5141 A (bone apatite): 1050 ± 145 BP (normalized, 1295 ± 150 BP).

Significance: Woodland, Blackduck

GX-5174 G, bone collagen, from Upper Area B (1977), Unit 34, Level 8, submitted by M.A. Tisdale

normalized age:	740 ± 105
	$\delta^{13}C$= ?‰
uncorrected age:	635 ± 105

Significance: Woodland, Blackduck

GX-5175 G, bone collagen, from Upper Area B (1977), Unit 33, Level 7, submitted by M.A. Tisdale

normalized age:	780 ± 105
	$\delta^{13}C$= ?‰
uncorrected age:	650 ± 105

Significance: Woodland, Blackduck

GX-5176 G, bone collagen, from Lower Area B (1977), Unit 55, Level 5, submitted by M.A. Tisdale

normalized age:	820 ± 130
	$\delta^{13}C$= ?‰
uncorrected age:	680 ± 130

Significance: Woodland, Blackduck

S-1273 (BU-76-2), bone collagen, from Area G, Unit 5, Level 6, collected 1976, submitted by E.L. Syms

normalized age:	1120 ± 50
	$\delta^{13}C$= -20‰e
uncorrected age:	1040 ± 45

Significance: Cultural affiliation unknown

S-2318, bone collagen, from Area F (1982), Unit 125, submitted by P.M. Badertscher

normalized age:	1120 ± 90
	$\delta^{13}C$= -20‰e
uncorrected age:	1040 ± 90

Significance: Woodland, Blackduck

S-2319, bone collagen, from Area F (1982), Unit 102, submitted by P.M. Badertscher

normalized age:	1130 ± 95
	$\delta^{13}C$= -20‰e
uncorrected age:	1050 ± 95

Significance: Woodland, Blackduck

SFU-229, bison bone collagen, *Bison* sp. humerus, from Upper Area B (1982), Unit 87, submitted by P.M. Badertscher

normalized age:	1180 ± 150
	$\delta^{13}C$= -20‰e
uncorrected age:	1100 ± 150

Significance: Woodland, Blackduck

SFU-224, bison bone collagen, *Bison* sp. radius, from Lower Area B (1982), Unit 98, submitted by P.M. Badertscher

normalized age:	1180 ± 150
	$\delta^{13}C$= -20‰e
uncorrected age:	1100 ± 150

Significance: Woodland, Blackduck

S-1272 (BU-76-1), bone collagen, from Area G, Unit 5, Level 6, collected 1976, submitted by E.L. Syms

normalized age:	1190 ± 65
	$\delta^{13}C$= -20‰e
uncorrected age:	1110 ± 60

Significance: Cultural affiliation unknown

GX-5139 G, bone collagen, from Area A (1977), Unit 14, Level 5, submitted by M.A. Tisdale

normalized age:	1200 ± 135
	$\delta^{13}C$= ?‰
uncorrected age:	1080 ± 135

Significance: Woodland, Blackduck

GX-5142 G, bone collagen, from Area A (1977), Unit 17, Level 6, submitted by M.A. Tisdale

normalized age:	1200 ± 135
	$\delta^{13}C$= ?‰
uncorrected age:	1080 ± 135

Note: GX-5142 A (bone apatite): 1610 ± 160 BP (normalized, 1855 ± 165 BP).

Significance: Woodland, Blackduck

GX-5177, charcoal, from Lower Area B (1977), Unit 53, Level 9, submitted by M.A. Tisdale

normalized age:	1320 ± 135
	$\delta^{13}C$= -25‰e
uncorrected age:	1320 ± 135

Significance: Cultural affiliation unknown

S-1303 (CMC-910), human bone collagen, *Homo sapiens*, from Burial XV-A:97, collected 1952, submitted by E.L. Syms

normalized age:	1460 ± 65
	$\delta^{13}C$= -19‰e
uncorrected age:	1360 ± 60

Note: The normalized age is a minimum, because bison that had consumed C_4 plants were probably included in the diet.

Significance: Woodland, unspecified

GX-5143 G, bone collagen, from Area A (1977), Unit 21, Level 11, submitted by M.A. Tisdale

normalized age:	3095 ± 160
	$\delta^{13}C$= ?‰
uncorrected age:	2990 ± 160

Note: GX-5143 A (bone apatite): 2670 ± 155 BP (normalized, 2915 ± 160 BP).

Significance: Cultural affiliation unknown

S-2320, soil humic acid, from Area F (1982), Unit 99, submitted by P.M. Badertscher

normalized age:	4200 ± 115
	$\delta^{13}C$= -25‰e
uncorrected age:	4200 ± 115

Significance: Cultural affiliation unknown; anomalous, old

EbKu-10, Astwood: on the east shore of George Lake in Whiteshell Provincial Park, Manitoba (NTS 52 L/03). This Laurel site has produced two anomalous dates. Sources: Buchner, 1979; Buchner and Callaghan, 1980.

GaK-5357, charcoal, from unreported provenience, submitted by A.P. Buchner

normalized age:	20 ± 75
	$\delta^{13}C$= -25‰e
uncorrected age:	20 ± 75

Significance: Woodland, Laurel, anomalous, young

GaK-5358, charcoal, from unreported provenience, submitted by A.P. Buchner

normalized age:	modern
	$\delta^{13}C$= -25‰e
uncorrected age:	modern

Significance: Woodland, Laurel, anomalous, young

EbKv-34, Slave Falls: on a slight southerly-oriented peninsula on the west bank of Winnipeg River just north of the Slave Falls hydroelectric station, Manitoba (NTS 52 L/05). Sources: Ens, 1998; Wyman, 1993.

NSRL-3125, human bone collagen (XAD-gelatin), *Homo sapiens* (1.23 mg), from feature 1, submitted by D.A. Ens

normalized age:	4010 ± 70
	$\delta^{13}C$= ?‰

Significance: Cultural affiliation unknown

EbKx-10, Whaley Cairn: on the north shore of a small island in Lee River, Winnipeg drainage, Manitoba (NTS 52 L/05). Sources: Ens, 1998; E.L. Syms, p.c. 1998; Wyman, 1993.

NSRL-3126, human bone collagen (XAD-gelatin), *Homo sapiens* (1.41 mg), from unit 2, feature 1, individual 5, submitted by D.A. Ens

normalized age:	1760 ± 60
	$\delta^{13}C$= ?‰

Significance: Cultural affiliation unknown

CAMS-13182, human bone collagen, *Homo sapiens*, from unit 2, feature 1, individual 1, submitted by E.L. Syms

normalized age:	1840 ± 60
	$\delta^{13}C$= -20.0‰

Significance: Cultural affiliation unknown

CAMS-13183, human bone collagen, *Homo sapiens*, from unit 2, feature 2, individual 5, submitted by E.L. Syms

normalized age:	1840 ± 60
	$\delta^{13}C$= -18.9‰

Significance: Cultural affiliation unknown

EbLo-VP, Portage diversion: the mouth of the Portage diversion on Lake Manitoba, 25 km north of Portage la Prairie, Manitoba. This sample was submitted by E. Nielsen to gain information on lake level change in Lake Manitoba, and the barrier beach transgression. The sample consisted of organic muck and fibrous plants, associated with muskrat and frog bones, and is interpreted as having been deposited in a marsh environment. Sources: GSC-XXXI; this report.

GSC-4864 (EN-89-1), peat from clay at the mouth of the Portage diversion, collected 1989, submitted by E. Nielsen

normalized age:	190 ± 50
	$\delta^{13}C$= -27.7‰
uncorrected age:	240 ± 50

Significance: Palaeobiology

EcKt-15, Tulabi Falls Portage: north of Whiteshell Provincial Park on Bird River near the inflow to Tulabi Lake, Manitoba (NTS 52 L/06). It is a multicomponent site, with Historic to Early Archaic or Palaeoindian material. The major occupation belongs to the Late Woodland Manitoba (Blackduck) or Selkirk phase, but the ceramics vary from those of other sites in the area. Twelve side-notched projectile points were recovered, 8 complete points of similar size

and grey chert material from a hearth in Unit 16, Level E, 13 cm depth. S-939 and S-940 were recovered from the same hearth. Sources: S-X.

S-940 (CMC-698), charred moose?, bear, and turtle bone collagen, *Alces*?, *Ursus* sp., and Testudines, from hearth, Unit 16, Level E, 13 cm depth, in humus, collected 1973.05, submitted by W.M. Hlady

normalized age:	510 ± 100
	$\delta^{13}C$= -20‰e
uncorrected age:	430 ± 100

Significance: Woodland, unspecified

S-939 (CMC-697), charcoal, from hearth, Unit 16, Level E, 13 cm depth, in humus, collected 1973.05, submitted by W.M. Hlady

normalized age:	1510 ± 200
	$\delta^{13}C$= -25‰e
uncorrected age:	1510 ± 200

Significance: Woodland, unspecified

EcKw-14, Two Eagles: Winnipeg drainage, Manitoba (NTS 52 L/05). Sources: E.L. Syms, p.c. 1998.

Beta-121722 (AMS), bone collagen, from cultural layer, submitted by E.L. Syms

normalized age:	3650 ± 40
	$\delta^{13}C$= -20.9‰
uncorrected age:	3590 ± 40

Significance: Archaic, Lee River complex

Beta-121723 (AMS), bone collagen, from cultural layer, submitted by E.L. Syms

normalized age:	3680 ± 50
	$\delta^{13}C$= -21.8‰
uncorrected age:	3630 ± 50

Significance: Archaic, Lee River complex

EcKx-4, Sinnock: on the east bank of the Winnipeg River, 246 m asl, 2 km southeast of Great Falls, southeastern Manitoba (NTS 52 L/05). This is a single component bison kill and butchering station assigned to the Plano horizon of the Palaeoindian tradition. It cannot have been occupied much earlier than the age given by OxA-116 due to the presence of glacial lake Agassiz. The modern age found for OxA-115 is not unexpected given the shallowness of the deposits at the site. This bone occurred 5-10 cm below the surface and could have been trampled to that location. The Palaeoindian occupation level occurs 15-20 cm below the surface. Although found on the surface, the bone dated by OxA-116 had previously been shown to be of great antiquity by a flourine test performed by R. Callaghan. Beta-4868 and OxA-508 consisted of 800 g of fill from a pit feature containing fine organic sediments with charcoal inclusions, and it is presumed to have been contaminated with carbon younger than the Palaeoindian occupation. The pit feature was filled with soil and contained dispersed charcoal, together with heat-treated chert. This feature, possibly a burial (but preserving no bone), was suspected to be younger than the rest of the site, but in the absence of diagnostic artifacts no firm statement could be made. Sources: OxA-2, OxA-5; Buchner, 1984a, 1984b; Pettipas and Buchner, 1983.

Beta-4868, sediment, from fine organic sediment with charcoal inclusions in a pit feature, submitted by A.P. Buchner

normalized age:	4295 ± 90
	$\delta^{13}C$= -25‰e
uncorrected age:	4295 ± 90

Significance: Cultural affiliation unknown

OxA-508, sediment, from fine organic sediment with charcoal inclusions in a pit feature, submitted by A.P. Buchner

normalized age:	4500 ± 80
	$\delta^{13}C$= ?‰

Significance: Cultural affiliation unknown

OxA-116, bone collagen, from surface of the site near an exposure near the centre of the site, submitted by A.P. Buchner

normalized age:	8030 ± 160
	$\delta^{13}C$= ?‰

Significance: Palaeoindian

OxA-115, bone collagen, from above the occupation level, 5-10 cm depth, submitted by A.P. Buchner

normalized age:	modern
	$\delta^{13}C$= ?‰
uncorrected age:	modern

Significance: Palaeoindian, anomalous, young

EcKx-37, Rivermouth: Winnipeg drainage, Manitoba (NTS 52 L/05). Sources: E.L. Syms, p.c. 1998.

Beta-121724 (AMS), bone collagen, from cultural layer, submitted by E.L. Syms

normalized age:	270 ± 60
	$\delta^{13}C$= -21.4‰
uncorrected age:	210 ± 60

Significance: Late Woodland, Protohistoric

Beta-121725 (AMS), bone collagen, from cultural layer, submitted by E.L. Syms

normalized age:	330 ± 40
	$\delta^{13}C$= -21.4‰
uncorrected age:	270 ± 40

Significance: Late Woodland / Protohistoric

EfKv-6, C5-b: on an island in Quesnel (Caribou) Lake, 282 m asl, about 13 km south of Bissett, Manitoba (NTS 52 L/13). Wheeler viewed this as an Agate Basin site and rejected both dates from the Geochron lab. However, DIC-1218 appears to confirm the age, and Buchner lists the site as a possible McKean component. Following two decades of additional research, the site may be seen as a manifestation of the Shield Archaic. Sources: Buchner, 1979; Wheeler, 1978.

GX-5049, charcoal, from Unit 3s1e, Level 6, upper hearth, 18-23 cm depth, submitted by C.J. Wheeler

normalized age: 3535 ± 175
$\delta^{13}C$= -25‰e
uncorrected age: 3535 ± 175

Significance: Middle Shield Archaic

DIC-1218, charcoal, from cultural layer, but provenience not reported, submitted by C.J. Wheeler and A.P. Buchner

normalized age: 3700 ± 100
$\delta^{13}C$= -25‰e
uncorrected age: 3700 ± 100

Significance: Middle Shield Archaic

GX-5048, charcoal, from Unit 3s1e, Level 9, lower hearth, 29-35 cm depth, submitted by C.J. Wheeler

normalized age: 3730 ± 160
$\delta^{13}C$= -25‰e
uncorrected age: 3730 ± 160

Significance: Middle Shield Archaic

EfKv-39, LM-8: on the shore of Manigotagan Lake, 282 m asl, about 20 km southeast of Bissett, Manitoba (NTS 52 L/13). Four components include Blackduck and Selkirk, Laurel, Larter or Pelican Lake phase, and Raddatz/Old Copper materials. The last-named component is assigned to the Middle Shield Archaic by Wright (1995). This site is reported with an incorrect Borden designation, EeKu-33. Sources: Buchner, 1979; Wright, 1995.

DIC-1216, turtle, fish, and bird bone collagen, from component 2, associated with dentated sherds, submitted by A.P. Buchner

normalized age: 940 ± 55
$\delta^{13}C$= -20‰e
uncorrected age: 860 ± 50

Significance: Woodland, Laurel

DIC-1217 b, wood, from component 2, associated with a bossed rimsherd, submitted by A.P. Buchner

normalized age: 1100 ± 110
$\delta^{13}C$= -25‰e
uncorrected age: 1100 ± 110

Significance: Woodland, Laurel

DIC-1217 a, bone collagen, from component 2, associated with a bossed rimsherd, submitted by A.P. Buchner

normalized age: 1180 ± 110
$\delta^{13}C$= -20‰e
uncorrected age: 1100 ± 105

Woodland, Laurel

DIC-1215, charcoal, from component 4, associated with Raddatz occupational debris, submitted by A.P. Buchner

normalized age: 3660 ± 75
$\delta^{13}C$= -25‰e
uncorrected age: 3660 ± 75

Significance: Middle Shield Archaic

GX-5802, charcoal, from component 4, base of feature 2-78, a cremation pit, submitted by A.P. Buchner

normalized age: 3870 ± 190
$\delta^{13}C$= -25‰e
uncorrected age: 3870 ± 190

Significance: Middle Shield Archaic

EgKx-1, Wanipigow: near Bissett, along 400-500 m of the southeastern shoreline of Wanipigow Lake, 320 m asl, southeastern Manitoba (NTS 52 M/04). This multi-component site has been divided into four named areas, each with its distinctive stratigraphy, culture history and modern vegetation: H.W. area, Hollow Water; W.L. area, Wanipigow Lake; C.P. area, Cabin Point; and C.L. area, Carlor. Ten radiocarbon samples were submitted to the Geochron lab from the W.L. area, and four samples were submitted to the same lab from the C.P. area. Four samples were too small to date.

S. Saylor (1989) suggests that the site was first occupied about 5000-6000 years ago based on point types from the lowest levels of the Cabin Point area. Archaic period occupation was sporadic and is represented mainly by Oxbow points. Middle Woodland occupations are represented by a variety of Laurel pottery types, most of which belong to middle and late Laurel styles. The most intensive and continuous occupations belong to the Late Woodland period, between A.D. 800-1000 and A.D. 1650-1700, when considerable quantities of Blackduck, Selkirk and Sandy Lake ware were deposited on the site. Detailed reports have been published on the soils (Zoltai, 1989a), plant macrofossils (Zoltai, 1989b), Laurel ceramics (B. Saylor, 1989), and projectile points (Hambly, 1994). A preliminary report (Saylor, 1977) lists faunal remains but does not explain the associations between taxa and occupation episodes. Data concerning radiocarbon sample size and provenience were conveyed with a memorandum from L. Pettipas to E. Nielsen that was forwarded to R. McNeely and R.E. Morlan. Sources: Buchner, 1979; Hambly, 1994; B. Saylor, 1989; S. Saylor, 1976, 1977, 1989; Zoltai, 1989a, 1989b.

GX-5497 (Sample 4), charcoal (8 g), from Cabin Point area, Unit 15, submitted by S. Saylor

normalized age: 255 ± 120
$\delta^{13}C$= -25‰e
uncorrected age: 255 ± 120

Significance: Woodland, Selkirk

GX-4067, bone collagen?, from Wanipigow Lake area, Unit 1, dark organic soil 8-10 cm thick, beneath 5-6 cm of sand, with two Selkirk vessels, collected 1975, submitted by S. Saylor

normalized age: 390 ± 125
$\delta^{13}C$= -20‰e
uncorrected age: 310 ± 125

Note: assumption that collagen was extracted.

Significance: Woodland, Selkirk

GX-4694 (Sample 8), charcoal (4 g), from Wanipigow Lake area, Unit 21, 25 cm depth, submitted by S. Saylor

normalized age: 960 ± 120
$\delta^{13}C$= -25‰e
uncorrected age: 960 ± 120

Significance: Woodland, late Laurel

GX-4691 (Sample 5), burned bone apatite (from 173 g), from Wanipigow Lake area, Unit 7. Bf2 horizon, 25-30 cm depth, submitted by S. Saylor

normalized age: 1060 ± 180
$\delta^{13}C$= -10‰e
uncorrected age: 815 ± 175

Significance: Woodland, Blackduck

GX-4689 (Sample 3), burned bone apatite (from 167 g), from Wanipigow Lake area, Unit 6, bottom Level 4, top Level 5, submitted by S. Saylor

normalized age: 1340 ± 155
$\delta^{13}C$= -10‰e
uncorrected age: 1095 ± 150

Significance: Woodland, Blackduck

GX-4690 (Sample 4), burned bone apatite (from 103 g), from Wanipigow Lake area, Unit 7, Bf3 horizon, 30 cm depth, submitted by S. Saylor

normalized age: 1365 ± 175
$\delta^{13}C$= -10‰e
uncorrected age: 1120 ± 170

Significance: Woodland, Laurel, Blackduck

GX-4693 (Sample 7), charcoal (25 g), from Wanipigow Lake area, Unit 24, 47-55 cm depth, post mold no. 2, submitted by S. Saylor

normalized age: 3495 ± 155
$\delta^{13}C$= -25‰e
uncorrected age: 3495 ± 155

Significance: Archaic, unspecified

GX-4692 (Sample 6), charcoal (38 g), from Wanipigow Lake area, Unit 24, 40-55 cm depth, post mold no. 1, submitted by S. Saylor

normalized age: 3510 ± 135
$\delta^{13}C$= -25‰e
uncorrected age: 3510 ± 135

Significance: Archaic, unspecified

GX-5494 G (Sample 1), beaver bone collagen, *Castor canadensis* (100 g), from Cabin Point area, Unit 6, submitted by S. Saylor

normalized age: modern
$\delta^{13}C$= -21.1‰
uncorrected age: modern

Significance: Woodland, Selkirk

GX-4066, bone collagen?, from Wanipigow Lake area, Unit 1, dark organic soil 8-10 cm thick, beneath 5-6 cm of sand, with two Selkirk vessels, collected 1975, submitted by S. Saylor

normalized age: modern
$\delta^{13}C$= -20‰e
uncorrected age: modern

Significance: Woodland, Selkirk, anomalous, young

EgKx-15, Thunderbird: along the northern shoreline of Wanipigow Lake, northwest of Bissett, Manitoba (NTS 52 M/04). Sources: Carmichael, 1979.

GX-5162 A, bone apatite, from Unit 10, submitted by P.H. Carmichael

normalized age: 3250 ± 130
$\delta^{13}C$= -10‰e
uncorrected age: 3005 ± 125

Significance: Cultural affiliation unknown

EaLa-1, Whitemouth Falls: south of Lac du Bonnet, 267 m asl, near Seven Sisters Falls, Manitoba (NTS 62 I/01). Four components include Late Woodland, McKean, Oxbow, and an early Holocene burial of unknown cultural affiliation. Sources: Buchner, 1979; Buchner and Pujo, 1977; Ens, 1998.

GaK-3747, wood, from component 1, submitted by J. Steinbring

uncorrected age: 0 ± 80
$\delta^{13}C$= -25‰e
normalized age: 0 ± 80

Significance: Woodland, unspecified, anomalous, young

GX-4415, bison bone collagen, *Bison* sp., from component 2, submitted by A.P. Buchner

normalized age: 3485 ± 175
$\delta^{13}C$= -20‰e
uncorrected age: 3405 ± 175

Significance: Archaic, McKean

GX-4416, bison bone collagen, *Bison* sp., from component 3, submitted by A.P. Buchner

normalized age: 4705 ± 150
$\delta^{13}C$= -20‰e
uncorrected age: 4625 ± 150

Significance: Archaic, Oxbow

GaK-4248, bison bone collagen, *Bison* sp., from component 3, submitted by J. Steinbring

normalized age: 4940 ± 150
$\delta^{13}C$= -20‰e
uncorrected age: 4860 ± 150

Significance: Archaic, Oxbow

NSRL-3128, human bone collagen (XAD-gelatin), *Homo sapiens* (0.97 mg), from Feature #10-76, a primary flexed human burial, submitted by D.A. Ens

normalized age: 6090 ± 90
$\delta^{13}C$= ?‰

Significance: Cultural affiliation unknown

GaK-6493, human bone collagen, *Homo sapiens*, from Feature #10-76, a primary flexed human burial, submitted by A.P. Buchner

normalized age: 6170 ± 110
$\delta^{13}C$= -19‰e
uncorrected age: 6070 ± 110

Significance: Cultural affiliation unknown

GaK-6494, human bone collagen, *Homo sapiens*, from Feature #10-76, a primary flexed human burial, submitted by A.P. Buchner

normalized age: 6450 ± 110
$\delta^{13}C$= -19‰e
uncorrected age: 6350 ± 110

Significance: Cultural affiliation unknown

EaLa-3, Bjorklund: on a ridge, 259 m asl, above the north shore of Whitemouth River near its confluence with Winnipeg River, southeastern Manitoba (NTS 62 I/01). Three components include Blackduck, Laurel, and Larter or Pelican Lake. Sources: Buchner, 1979, 1982; Ens, 1998; Meiklejohn, et al. 1994.

GaK-4712, moose bone collagen, *Alces alces*, from component 1, submitted by A.P. Buchner

normalized age: 700 ± 80
$\delta^{13}C$= -20‰e
uncorrected age: 620 ± 75

Significance: Woodland, Blackduck

GX-4146, beaver and moose bone collagen, *Castor canadensis* and *Alces alces*, from component 1, submitted by A.P. Buchner

normalized age: 815 ± 120
$\delta^{13}C$= -20‰e
uncorrected age: 735 ± 120

Significance: Woodland, Blackduck

GX-4143, red fox bone collagen, *Vulpes vulpes*, from component 1, submitted by A.P. Buchner

normalized age: 1000 ± 105
$\delta^{13}C$= -19‰e
uncorrected age: 900 ± 105

Significance: Woodland, Blackduck

GX-4142, beaver, otter, bear, moose, hare, and muskrat bone collagen, *Castor, Lutra, Ursus, Alces, Lepus*, and *Ondatra*, from component 1, submitted by A.P. Buchner

normalized age: 1003 ± 125
$\delta^{13}C$= -20‰e
uncorrected age: 923 ± 125

Significance: Woodland, Blackduck

GX-3603, charcoal, from component 2, unit S55/E30, Feature 6-74, Level 15, from base of pit feature, submitted by J. Steinbring

normalized age: 1230 ± 155
$\delta^{13}C$= -25‰e
uncorrected age: 1230 ± 155

Significance: Woodland, Laurel ?

NSRL-3127, human bone collagen (XAD-gelatin), *Homo sapiens* (1.44 mg), from component 2, feature 6-74, individual Z17, submitted by D.A. Ens

normalized age: 1570 ± 60
$\delta^{13}C$= ?‰

Significance: Woodland, Laurel ?

GaK-5447, human bone collagen, *Homo sapiens*, from component 2, unit S55/E30, Feature 6-74, Level 15, bone within pit feature, submitted by J. Steinbring

normalized age: 1360 ± 80
$\delta^{13}C$= -19‰e
uncorrected age: 1260 ± 80

Significance: Woodland, Laurel ?

GX-4144, bison bone collagen, *Bison* sp., from component 3, submitted by A.P. Buchner

normalized age: 2785 ± 120
$\delta^{13}C$= -20‰e
uncorrected age: 2705 ± 120

Significance: Archaic, Pelican Lake (Larter)

GaK-4713, bison bone collagen, *Bison* sp., from component 3, submitted by A.P. Buchner

normalized age: 2830 ± 95
$\delta^{13}C$= -20‰e
uncorrected age: 2750 ± 95

Significance: Archaic, Pelican Lake (Larter)

GX-4148, charcoal, from component 3, submitted by A.P. Buchner

normalized age: 2950 ± 130
$\delta^{13}C$= -25‰e
uncorrected age: 2950 ± 130

Significance: Archaic, Pelican Lake (Larter)

GX-4149, bison bone collagen, *Bison* sp., from component 3, submitted by A.P. Buchner

uncorrected age: 2840 ± 130
$\delta^{13}C$= -20‰e
normalized age: 2920 ± 130

Significance: Archaic, Pelican Lake (Larter)

GX-4150, bison and beaver bone collagen, *Bison* sp. and *Castor canadensis*, from component 3, submitted by A.P. Buchner

normalized age: 3025 ± 160
$\delta^{13}C$= -20‰e
uncorrected age: 2945 ± 160

Significance: Archaic, Pelican Lake (Larter)

GX-4147, bison bone collagen, *Bison* sp., from component 3, submitted by A.P. Buchner

normalized age: 3185 ± 105
$\delta^{13}C$= -20‰e
uncorrected age: 3105 ± 105

Significance: Archaic, Pelican Lake (Larter)

GX-4145, bison bone collagen, *Bison* sp. innominate, from component 3, unit N70/E45, Feature 2-75, Level 4B-6, submitted by A.P. Buchner

normalized age: 3205 ± 135
$\delta^{13}C$= -20‰e
uncorrected age: 3125 ± 135

Significance: Archaic, Pelican Lake (Larter)

EaLf-1, Lockport: on the east bank of the Red River, just north of Winnipeg, Manitoba (NTS 62 I/02). This site is unusually important for several reasons. It contains one of the few deeply stratified sequences in Manitoba. It has produced evidence of the northernmost aboriginal corn horticulture in Canada. It is well dated by a series of 14 radiocarbon measurements that aid the reconstruction of fluvial sedimentology and palaeoecology in the Red River valley. The exact provenience and cultural affiliation of two AMS dates from the RIDDL lab have not yet been reported. Sources: Buchner, 1988; Deck and Shay, 1992; Nielsen, et al. 1993; Roberts, 1992.

RIDDL-1272, bone collagen, from 0.78 m depth, submitted by A.P. Buchner

normalized age: 595 ± 80
$\delta^{13}C$= -20‰e

Significance: Cultural affiliation unknown

RIDDL-1273, bone collagen, from 0.57 m depth, submitted by A.P. Buchner

normalized age: 705 ± 75
$\delta^{13}C$= -20‰e

Significance: Cultural affiliation unknown

S-2852, charcoal (12.3 g), from Bed B, N132/W37, 0.63 m depth but originating in a higher level, collected 1986, submitted by A.P. Buchner

normalized age: 315 ± 235
$\delta^{13}C$= -25‰e
uncorrected age: 315 ± 235

Significance: Woodland, Selkirk

S-2850, charcoal (8.0 g), from Bed B/C, N124/W34, contact of Beds B and C, 0.37 m depth, collected 1986, submitted by A.P. Buchner

normalized age: 470 ± 270
$\delta^{13}C$= -25‰e
uncorrected age: 470 ± 270

Significance: Woodland, terminal Blackduck

S-2849, charcoal (24.5 g), from Bed C/E, N124/W35, contact of Beds C and E where Bed D is absent, 0.83 m depth, collected 1986, submitted by A.P. Buchner

normalized age: 635 ± 90
$\delta^{13}C$= -25‰e
uncorrected age: 635 ± 90

Significance: Woodland, Blackduck

GX-10866, charcoal (40.0 g), from Bed D, N175/W43, 0.82 m depth, collected 1984, submitted by A.P. Buchner

normalized age: 620 ± 105
$\delta^{13}C$= -25‰e
uncorrected age: 620 ± 105

Significance: Woodland, Blackduck

S-2851, charcoal (17.0 g), from Bed E/F, N125/W34, contact of Beds E and F, 0.75 m depth, collected 1986, submitted by A.P. Buchner

normalized age: 1005 ± 280
$\delta^{13}C$= -25‰e
uncorrected age: 1005 ± 280

Significance: Woodland, early Blackduck

S-2853, charcoal (95.0 g), from Bed E/F, N147/W33, contact of Beds E and F, 1.53 m depth, collected 1985, submitted by A.P. Buchner

normalized age: 1095 ± 250
$\delta^{13}C$= -25‰e
uncorrected age: 1095 ± 250

Significance: Woodland, early Blackduck

S-2848, charcoal (22.2 g), from Bed E/F, N125/W34, contact of Beds E and F, 0.83 m depth, collected 1986, submitted by A.P. Buchner

normalized age: 1185 ± 255
$\delta^{13}C$= -25‰e
uncorrected age: 1185 ± 255

Significance: Woodland, late Laurel

S-2854, charcoal (9.1 g), from Bed E/F, N131/W39, contact of Beds E and F, 0.93 m depth, collected 1986, submitted by A.P. Buchner

normalized age: 1185 ± 255
$\delta^{13}C$= -25‰e
uncorrected age: 1185 ± 255

Significance: Woodland, late Laurel

GX-10865, bone collagen (from 155.0 g), from Bed F, N142/W36, 1.42 m depth, collected 1984, submitted by A.P. Buchner

normalized age: 1490 ± 290
$\delta^{13}C$= -20‰e
uncorrected age: 1410 ± 290

Significance: Woodland, Laurel

GX-10864, bone collagen (from 785.0 g), from Bed G/H, N122/W36, contact of Beds G and H, 1.57 m depth, collected 1984, submitted by A.P. Buchner

normalized age: 2395 ± 85
$\delta^{13}C$= -20‰e
uncorrected age: 2315 ± 85

Significance: Archaic, Pelican Lake (late Larter)

GX-10863, bison bone collagen, *Bison* sp. vertebra (216.0 g), from Bed H, Exposure 6, 1.90 m depth, collected 1984, submitted by A.P. Buchner

normalized age: 2595 ± 140
$\delta^{13}C$= -20‰e
uncorrected age: 2515 ± 140

Significance: Archaic, Pelican Lake (Larter)

S-2847, charcoal (111.9 g), from Bed H/I, N125/W34, contact of Beds H and I, 2.10 m depth, collected 1986, submitted by A.P. Buchner

normalized age: 3300 ± 295
$\delta^{13}C$= -25‰e
uncorrected age: 3300 ± 295

Significance: Archaic, Pelican Lake (early Larter)

EaLf-3, Fidler Mounds: on the east bank of Red River, near Lockport, Manitoba (NTS 62 I/02). The dated mound is a multiple mode burial mound, 1 m above terrain surface and 1 m deep. Sources: S-X.

S-225, charcoal, from floor of burial mound, collected 1963, submitted by T. Fiske

normalized age: 380 ± 80
$\delta^{13}C$= -25‰e
uncorrected age: 380 ± 80

Significance: Cultural affiliation unknown

EaLf-10, Eveline Street Burial: was located in the town of Selkirk, on the west bank of the Red River, Manitoba (NTS 62 I/02). S-942 and S-943 were submitted to determine a cultural phase assignment. Sources: S-X.

S-943 (CMC-701), charcoal, from human burial, Unit 5, Level F, 50-52 cm depth, rich black topsoil, collected 1973.07.17, submitted by W.M. Hlady

normalized age: 505 ± 105
$\delta^{13}C$= -25‰e
uncorrected age: 505 ± 105

Significance: Cultural affiliation unknown

S-942 (CMC-700), charcoal, from human burial, Unit 5, Level F, 41-46 cm depth, rich black topsoil, collected 1973.07.17, submitted by W.M. Hlady

normalized age: 780 ± 65
$\delta^{13}C$= -25‰e
uncorrected age: 780 ± 65

Significance: Cultural affiliation unknown

EaLf-VP, St. Andrews: right (east) bank of the Red River, opposite St. Andrews, Manitoba (NTS 62 I/02). A 3.2 m section is believed to have been deposited by overbank sedimentation during floods spanning the last 5000 years. Bison bones from a palaeosol were submitted for a radiocarbon date. Sources: Nielsen et al., 1993.

BGS-927, bison bone collagen, *Bison* sp. ribs and vertebrae, from a palaeosol developed in silty clay, 2.0 m depth in a 3.2 m section, submitted by E. Nielsen

normalized age: 3710 ± 100
$\delta^{13}C$= -20‰e
uncorrected age: 3630 ± 100

Significance: Palaeobiology

EaLg-9, Wright: left (west) bank of the Red River, just northeast of the city of Winnipeg, near the mouth of Parkes Creek, Manitoba (NTS 62 I/03). Six sections were examined along a 20 m stretch just upstream from the creek mouth. Bison bones from section A were submitted for radiocarbon dating. This section exposed four prominent soils, four bone horizons, two charcoal layers, and two reddish-brown zones formed by burning. It was subsequently investigated as an archaeological site, situated at what is now the largest and most prominent rapids on the Red River. Sources: Nielsen et al. 1993, 1996.

BGS-926, bison bone collagen, *Bison* sp., from section A, 1.4 m depth, in a palaeosol developed in silty clay, submitted by E. Nielsen

normalized age: 3640 ± 100
$\delta^{13}C$= -20‰e
uncorrected age: 3560 ± 100

Significance: Cultural affiliation unknown

BGS-1801, bone collagen, from section A, 0.75 m depth, submitted by E. Nielsen

normalized age: 3705 ± 75
$\delta^{13}C$= -20‰e
uncorrected age: 3625 ± 70

Significance: Cultural affiliation unknown

BGS-1802, bone collagen, from section A, 1.06 m depth, submitted by E. Nielsen

normalized age: 4020 ± 80
$\delta^{13}C$= -20‰e
uncorrected age: 3940 ± 80

Significance: Cultural affiliation unknown

BGS-1803, bone collagen, from section A, 1.40 m depth, submitted by E. Nielsen

normalized age: 5000 ± 100
$\delta^{13}C$= -20‰e
uncorrected age: 4920 ± 100

Significance: Cultural affiliation unknown

BGS-920, freshwater mollusc shells, Unionidae, from section A, 4.5 m depth, submitted by E. Nielsen

normalized age: 5255 ± 135
$\delta^{13}C$= -8‰e
uncorrected age: 4980 ± 125

Significance: Cultural affiliation unknown

BGS-921, freshwater mollusc shells, Unionidae, from section F, 3.4 m depth, submitted by E. Nielsen

normalized age: 5275 ± 110
$\delta^{13}C$= -8‰e
uncorrected age: 5000 ± 100

Significance: Cultural affiliation unknown

BGS-1804, bone collagen, from section A, 2.55 m depth, submitted by E. Nielsen

normalized age: 5410 ± 80
$\delta^{13}C$= -20‰e
uncorrected age: 5330 ± 80

Significance: Cultural affiliation unknown

EbLb-no #, Lac du Bonnet: Winnipeg River, southeastern Manitoba (NTS 62 I/08). An interesting bone is described by A.P. Buchner and L. Roberts. Over the last 35 years the Lac du Bonnet "elephant" bone has repeatedly been cited as possible evidence for the contemporaneity of man and mammoths and mastodons in this part of the North American continent. It presented several problems, however: lack of assurance that the bone was worked green rather than some period after the death of the animal; the presence of glacial Lake Agassiz over the site until a time more recent than the generally accepted date for the extinction of these animals; and the absence of evidence of Clovis Culture - the only commonly recognised elephant hunting complex - from this area. Since its discovery the specimen has been kept under rather tight security and only casts were displayed and circulated. The very recent date called the identification into question and prompted re-examination. The bone appears to be that of a large adult male moose (*Alces alces*). The clearly visible sutures, which did not reproduce well in the casts, are indicative of a cranium, probably where the frontals and parietals join. The depressions of the under surface relate to the cranial vault. The middle and tapering sections are antler with the area of the pedicle worn smooth. The tapered point is probably the first tyne off the palmate section of the antler. Indirectly accelerator dating has served to remove this anomaly from the body of data concerning Early Man in the New World. Sources: OxA-2; Buchner and Roberts, 1990.

OxA-385, moose bone collagen, *Alces alces*, from context unknown, submitted by A.P. Buchner

normalized age: 920 ± 100
$\delta^{13}C$= ?‰

Significance: Cultural affiliation unknown

EcLx-VP: a 26 m-high road cut along the Minnedosa River valley, Manitoba (NTS 62 J/05), yielded bones and plant remains that may have been deposited during an interstadial. Klassen comments that the close resemblance of bones to those of Arctic ground squirrel (*Spermophilus parryii*) and tundra vole (*Microtus oeconomus*) suggest that the silt is an interstadial deposit. Harington, however, declines to mention species names. Sources: GSC-V; Harington, 1990; Klassen et al., 1967.

GSC-297 (KJ-52-64), organic material, grass, from inter-till silt overlain by three tills separated by stratified sediments, associated with ground squirrel and vole bones, collected 1964, submitted by R.W. Klassen

normalized age: >31 300
$\delta^{13}C$= -25‰e
uncorrected age: >31 300

Significance: Palaeobiology

EdLb-no #, Fort Alexander (FA3): near the mouth of Winnipeg River, Manitoba (NTS 62 I/09). Sources: Ens, 1998.

NSRL-3129, human bone collagen (XAD-gelatin), *Homo sapiens* (1.34 mg), from burial 1, submitted by D.A. Ens

normalized age: 250 ± 60
$\delta^{13}C$= ?‰

Significance: Cultural affiliation unknown

NSRL-3130, human bone collagen (XAD-gelatin), *Homo sapiens* (1.40 mg), from burial 2, submitted by D.A. Ens

normalized age: 450 ± 60
$\delta^{13}C$= ?‰

Significance: Cultural affiliation unknown

EfLl-no #, Eriksdale: near Eriksdale, in the inter-lake area, Manitoba (NTS 62 I/13). Syms considers S-651 too old. A small Pelican Lake point was embedded in the femur with evidence of a healed wound. Sources: S-IX; Syms, 1983.

S-651 (UM-A-LAB1), human bone collagen, *Homo sapiens* tibia, from burial, collected 1971, submitted by J. Maas, E.L. Syms

normalized age: 3460 ± 100
$\delta^{13}C$= -19‰e
uncorrected age: 3360 ± 100

Significance: Archaic, Pelican Lake

EaMg-12, Miniota: in the Assiniboine River valley, just north of Miniota, Manitoba (NTS 62 K/03). In view of the discrepancy between the Beta dates, two bone samples were dated by the Brock lab with results close to the charcoal date. Sources: Landals, 1995; E. Nielsen, p.c. 1998.

Beta-58907, bone collagen, from cultural layer, submitted by A. Landals

normalized age: 970 ± 90
$\delta^{13}C$= -18.4‰
uncorrected age: 870 ± 90

Significance: Woodland, Avonlea, anomalous, young

Beta-58908, charcoal, from hearth in cultural layer, submitted by A. Landals

normalized age: 1340 ± 90
$\delta^{13}C$= -25‰e
uncorrected age: 1340 ± 90

Significance: Woodland, Avonlea

BGS-1791, bone collagen (from 220 g), from clay matrix, 150 cm depth, submitted by E. Nielsen

normalized age: 1620 ± 75
$\delta^{13}C$= -20‰e
uncorrected age: 1540 ± 70

Significance: Woodland, Avonlea

BGS-1792, bone collagen (from 330 g), from clay matrix, 150 cm depth, submitted by E. Nielsen

normalized age: 1640 ± 75
$\delta^{13}C$= -20‰e
uncorrected age: 1560 ± 70

Significance: Woodland, Avonlea

EeMi-VP: a diversion channel cut in the Assiniboine River floodplain, 10 km west of Russell, Manitoba (NTS 62 K/14). GSC-280 was taken from the bottom of a cut in an organic clay zone containing twigs and bone fragments along with a bison skull. The zone is overlain by 4 m of silty clay including beds of pelecypod-bearing silt, sand, and gravel, and is underlain by 18 m of clay, in part probably lacustrine. Klassen interprets the date as marking a late phase in valley filling. Sources: GSC-IV; Reeves, 1973.

GSC-280 (KF-36-64), wood (twigs), from clayey alluvium associated with a bison skull, collected 1964, submitted by R.W. Klassen

normalized age: 6320 ± 140
$\delta^{13}C$= -25‰e
uncorrected age: 6320 ± 140

Significance: Palaeobiology

EhMd-VP, Grandview: south side of the Valley River, 4.8 km east of Grandview, Manitoba (NTS 62 N/02). A muskox skull fragment was recovered by a heavy equipment operater working at a gravel deposit. Stratigraphic information was obtained by R.W. Klassen, and the skull was identified and dated by C.R. Harington.

Harington postulates that the muskox represents herds that survived in a refugium south of Wisconsinan ice, then moved north with the tundra zone bordering the backmelting continental ice until they reached their present range in the Northwest Territories mainland. Harington notes that the great distance of the ice front north of Grandview 8600 years ago, and palaeobotanical evidence for grassland in the Duck Mountain area at that time (Ritchie, 1969), suggest that I-1623 may be erroneously recent. It should perhaps be considered a minimum age. Sources: Harington, 1970, 1978.

I-1623, muskox bone collagen, *Ovibos moschatus* (id. by C.R. Harington), from sand and gravel beneath about 3 m of alluvium, about 1.5 m above the present channel bottom, collected 1963, submitted by C.R. Harington

normalized age: 8700 ± 190
$\delta^{13}C$= -20‰e
uncorrected age: 8620 ± 190

Significance: Palaeobiology

FaMi-VP: a natural river cut along the Swan River, 2.5 km southwest of Harlington, Manitoba (NTS 63 C/03). M.C. Wilson determined that the bones are typical of a mid- to late Holocene female bison. Sources: Nielsen, 1988.

BGS-1100, bison bone collagen, *Bison* sp. metacarpal and ungual phalanx, from calcareous silt exposed in a natural river cut, 3 m depth, 1 m below a prominent palaeosol, collected 1985, submitted by E. Nielsen

normalized age: 7040 ± 100
$\delta^{13}C$= -20‰e
uncorrected age: 6960 ± 100

Significance: Palaeobiology

FbMb-1, Aschkibokahn (or Duck River, or C3-MD-1): on an island in Duck Bay, 252 m asl, on the western side of Lake Winnipegosis, Manitoba (NTS 63 C/01). This site was excavated by J.S. Snortland-Coles in 1976 and by P. Badertscher in 1977. It suffers from compressed stratigraphy and may contain the remains of more than one occupation representing a considerable span of time. However, the entire record presumably relates to the Late Woodland period. Two ceramic styles, Blackduck ware and Duck Bay ware, may or may not be contemporaneous but both are representative of Late Woodland. Snortland-Coles (1979: 49) reports that DIC-845 and -846 may be affected by "the small size of the carbon samples (less than 10 grams) and the fact that the radioisotope laboratory which processed the samples suffered two power reductions necessitating recalibration of the equipment (Irene Stehli, personal communication)." These dates, from the middle levels of the site, are older than two dates (GX-5516, -5517) obtained by Badertscher from the lower levels of the site. However, all four dates fall within the time span established for the Late Woodland period elsewhere in Manitoba. Sources: Hanna, 1981, 1992; Snortland-Coles, 1979, citing P. Badertscher, pers. comm.

GX-5516, charcoal, from lower levels of the site, submitted by P. Badertscher

normalized age: 695 ± 175
$\delta^{13}C$= -25‰e
uncorrected age: 695 ± 175

Significance: Woodland, Blackduck

GX-5517, charcoal, from lower levels of the site, submitted by P. Badertscher

normalized age: 770 ± 110
$\delta^{13}C$= -25‰e
uncorrected age: 770 ± 110

Significance: Woodland, Blackduck

DIC-845, charcoal, from middle levels, with main concentration of ceramics, submitted by J.S. Snortland-Coles

normalized age: 1260 ± 285
$\delta^{13}C$= -25‰e
uncorrected age: 1260 ± 285

Significance: Woodland, Blackduck

DIC-846, charcoal, from middle levels, with main concentration of ceramics, submitted by J.S. Snortland-Coles

normalized age: 1270 ± 275
$\delta^{13}C$= -25‰e
uncorrected age: 1270 ± 275

Significance: Woodland, Blackduck

FbMf-1: on the east bank of the Swan River, 11 km east of Bowsman, Manitoba (NTS 63 C/07). S-3222 was associated with a heavy concentration of pottery, bone, and lithic tools and debitage. Sources: Wowchuk, 1990.

S-3222, bone collagen, from 5 cm thick level, 15 cm depth, submitted by G. Wowchuk

normalized age: 580 ± 55
$\delta^{13}C$= -20‰e
uncorrected age: 500 ± 50

Significance: Woodland, unspecified

FbMf-5: in the Swan River valley, Manitoba (NTS 63 C/07). S-3224 was associated with fish and small mammal bone, lithic debitage and ceramics. S-3223 was associated with large and medium-size mammal bone, lithic tools and debitage, and ceramics. Sources: Wowchuk, 1990.

S-3224, charcoal, from paleosol, 55 cm depth, submitted by G. Wowchuk

normalized age: 300 ± 60
$\delta^{13}C$= -25‰e
uncorrected age: 300 ± 60

Significance: Woodland, unspecified

S-3223, charcoal, from paleosol, 85 cm depth, submitted by G. Wowchuk

normalized age: 490 ± 50
$\delta^{13}C$= -25‰e
uncorrected age: 490 ± 50

Significance: Woodland, unspecified

FbMh-VP, Bowsman: 6.4 km west of Bowsman, Bowsman River, Manitoba (NTS 63 C/03). M.C. Wilson examined the bison bones and determined that they are typical for a mid- to late Holocene female bison. Sources: Nielsen, 1988.

BGS-728, bison bone collagen, *Bison* sp. atlas and calcaneus, from very hard silt and clay exposed in a roadside ditch, the hardness perhaps due to pedogenesis in an alluvial fan, 1 m depth, collected 1979, submitted by E. Nielsen

normalized age: 5430 ± 120
$\delta^{13}C$= -20‰e
uncorrected age: 5350 ± 120

Significance: Palaeobiology

FbMi-5, Swan River or Swamp: at the toe of the Upper Campbell beach, 350-358 m asl, Swan River valley, Manitoba (NTS 63 C/06). Underlying parent material is composed of Lake Agassiz (Upper Campbell beach) sands and clays, the upper portion bearing evidence of gleying. The site is an early prehistoric campsite with side-notched projectile points resembling those found in Iowa in the Logan Creek Complex.

Comment (W. Blake, Jr.): Although dates on material from Lake Agassiz beach were far younger than expected (cf. Elson, 1967) agreement between collagen fraction of butchered bone and organic sediment at same depth is striking. Recovery of collagen by a procedure using $SrCO_3$, giving a result of 2270 ± 130 years (GSC-1219-2), is reported in GSC-XI: 258-259. Colwill (1973) considered the dates to be appropriate for the site. New excavations by Badertscher (1980) resulted in four dates from the Saskatchewan laboratory. Sources: GSC-X, GSC-XII, S-X; Badertscher, 1980; Colwill, 1973; Ehrlich, et al. 1962; Elson, 1967; Gryba, 1968; Klassen, 1969.

S-1951 (CMC-1171), bison bone collagen, *Bison* sp. distal humerus, from peat-gray clay interface, Unit 28n2w, Level 5, collected 1979.08.08, submitted by P. Badertscher

normalized age: 390 ± 75
$\delta^{13}C$= -20‰e
uncorrected age: 310 ± 70

Significance: Cultural affiliation unknown

S-2029 (CMC-1203), peat, from basal peat overlying gray sandy loam, Units 26n2w/24n2w, 61-65 cm depth, collected 1980.08.22, submitted by P. Badertscher

normalized age: 720 ± 60
$\delta^{13}C$= -24.9‰
uncorrected age: 720 ± 60

Significance: Cultural affiliation unknown

S-1952 (CMC-1172), charcoal, from basal peat overlying clay zone, Unit 30n2w, 62 cm depth, collected 1979.08.28, submitted by P. Badertscher

normalized age: 1670 ± 70
$\delta^{13}C$= -24.9‰
uncorrected age: 1670 ± 70

Significance: Cultural affiliation unknown

GSC-1219, bone collagen (from 525 g), from contact zone between peat and underlying lacustrine sediments, collected 1968, submitted by R.W. Klassen

normalized age:	2320 ± 130
	$\delta^{13}C$= -21.2‰
uncorrected age:	2260 ± 130

Note: Pretreatment included a 1-hour NaOH-leach; sample mixed with dead gas for counting.

Significance: Cultural affiliation unknown

GSC-1308, organic sediment (decomposed aquatic muck), from Square 20N-6W, east wall, 75 cm depth; in base of bog composed of woody peat, collected 1969, submitted by L. Pettipas

normalized age:	2330 ± 130
	$\delta^{13}C$= -24.9‰
uncorrected age:	2330 ± 130

Note: NaOH-leach omitted from pretreatment; 30 g burned after HCl treatment.

Significance: Cultural affiliation unknown

S-2028 (CMC-1202), bone collagen, from base of gray sand horizon overlying yellow sand, Unit 17s45e, 62 cm depth, collected 1980.07.05, submitted by P. Badertscher

normalized age:	13 060 ± 3190
	$\delta^{13}C$= -20‰e
uncorrected age:	12 980 ± 3190

Significance: Cultural affiliation unknown

FbMi-VP, Hubbell Creek: 13 km northwest of town of Swan River, 344 m asl, on the flanks of the Porcupine Hills, Manitoba (NTS 63 C/03). Water-worn bison bone fragments were recovered from screened stock piles at several gravel pits developed in deposits related to the Campbell Beach of Glacial Lake Agassiz. Sources: Nielsen, 1988; Nielsen et al., 1984.

BGS-887, bison bone collagen, *Bison* sp., from screened stock pile at gravel pit D, abraded bone, collected 1978, submitted by E. Nielsen

normalized age:	9480 ± 125
	$\delta^{13}C$= -20‰e
uncorrected age:	9400 ± 125

Significance: palaeobiology

BGS-840, bison bone collagen, *Bison* sp., from screened stock pile at gravel pit F, abraded bone, collected 1978, submitted by E. Nielsen

normalized age:	9580 ± 120
	$\delta^{13}C$= -20‰e
uncorrected age:	9500 ± 120

Significance: palaeobiology

BGS-617, bison bone collagen, *Bison* sp., from screened stock pile at gravel pit B, abraded bone, collected 1978, submitted by E. Nielsen

normalized age:	10 380 ± 200
	$\delta^{13}C$= -20‰e
uncorrected age:	10 300 ± 200

Significance: palaeobiology

FdMi-1, Steeprock Lake: in a provincial campground in Porcupine Forest Reserve along Steeprock Lake, 740 m asl, Manitoba (NTS 63 C/11). The site is situated on two terraces, the upper one relatively undisturbed, the lower one modified by an early high water level of the lake. Cultural materials associated with the upper terrace relate to late Palaeoindian, Early and Late Archaic. The early component appears to be dominated by Early Archaic tool forms with Simonsen/Logan Creek affiliations. It is overlain by later undisturbed cultural materials.

Wilmeth (1978: 116) provides a summary comment: Since the samples were dated in two series, the following remarks summarize two sets of comments by Hlady. All three dates are from a dark red sand layer which includes Agate Basin, Plainview, and Archaic side-notched projectile forms. This is overlain by gray-red sand which includes a crude flat side-notched/ basal-notched McKean variant and thin crude eared stemmed corner-notched points. Below the dark red sand, which varied in depth and thickness, was a sterile light red sand. Hlady believed the first date obtained (S-479) was too recent for the older assemblage, and that the shallow firepit may have been an intrusion from the gray-red sand zone. Commenting on two dates obtained later, he points out that while the colour variations were readily evident in the profiles, the changes were extremely difficult to recognize while trowelling downward. Arbitrary two inch levels were therefore used. However, this use of the surface as a datum, while adequate for measuring the position of artifacts, is inappropriate for relating the position to the strata across the site. But if the top of the sterile light red sand, assumed to be the surface when site habitation began, is used as a datum, and if the carbon sample positions are plotted as distance above datum, then there is a surprisingly consistent relationship between position and time. Sources: S-VI, S-VIII; Simpson, 1970, 1974; Wilmeth, 1978.

S-615 (CMC-457), charcoal, from apparent hearth, dark red sand, square 205n/10w, Level 5, 20.3-30.5 cm depth, collected 1970.08.17, submitted by W.M. Hlady

normalized age:	2480 ± 120
	$\delta^{13}C$= -25‰e
uncorrected age:	2480 ± 120

Significance: Cultural affiliation unknown

S-479 (CMC-272), charcoal, from bottom dark red sand zone, square 200n/30w, Level 5, 25.4 cm depth, collected 1967.07.20, submitted by W.M. Hlady

normalized age:	3130 ± 110
	$\delta^{13}C$= -25‰e
uncorrected age:	3130 ± 110

Significance: Cultural affiliation unknown

S-616 (CMC-458), charcoal, from dark red sand, square 225n/20w, Level 3, 15.2-20.3 cm depth, collected 1970.08.20, submitted by W.M. Hlady

normalized age: 3950 ± 130
$\delta^{13}C$= -25‰e
uncorrected age: 3950 ± 130

Significance: Cultural affiliation unknown

FgMc-2, Oscar Point (PAH5): on Oscar Point, 244 m asl, 800 m southwest of highway 327, at north end of Lake Winnipegosis, along south edge of The Pas end moraine, Manitoba (NTS 63 F/01). Sources: S-X; Dickson, 1976; Kelly and Connell, 1978.

S-1451, charcoal and burned bone collagen, from unit 2, F-203, submitted by M.E. Kelly

normalized age: 345 ± 55
$\delta^{13}C$= -25‰e
uncorrected age: 345 ± 55

Note: assumption that charcoal was the main constituent.

Significance: Woodland, unspecified

S-1452, charcoal, from unit 2 floor, submitted by M.E. Kelly

normalized age: 360 ± 60
$\delta^{13}C$= -25‰e
uncorrected age: 360 ± 60

Significance: Woodland, unspecified

S-1079, bone collagen (from 157 g), from glacial "till," Test unit 2A, W1 Terrace, 6-12 cm depth, collected 1975.09, submitted by G. Dickson

normalized age: 1220 ± 75
$\delta^{13}C$= -20‰e
uncorrected age: 1140 ± 70

Significance: Woodland, Laurel

FkMh-5, Pas Reserve: on the north bank of the Saskatchewan River, 267 m asl, opposite the outlet of Pasquia River, Manitoba (NTS 63 F/14). This stratified campsite has four components, Selkirk, Avonlea, Laurel, and Duncan from youngest to oldest, but they are not always well separated stratigraphically.

In 1992, a burial was discovered during a basement excavation near the campsite. The burial was accompanied by three projectile points, including a Besant point and two previously unknown types. The campsite has been reported with an incorrect Borden designation, FlMh-2. Sources: A-X; Long and Tamplin, 1977; Syms, 1992, p.c. 1998; Tamplin, 1977; Tamplin, et al. 1983.

A-1183, aspen? charcoal (10 g), *Populus* sp. (id. by A. Long and J.H. McAndrews), from Unit 4n4w, on top of clay-silt layer above Layer 1a, 75 cm below datum, submitted by M. Tamplin

normalized age: 280 ± 100
$\delta^{13}C$= -25‰e
uncorrected age: 280 ± 100

Significance: Woodland, Selkirk?, minimum age

A-1293, charcoal (6.1 g), from hearth in humic silt, Unit 2n6w, Layer 1a, 77 cm below datum, submitted by M. Tamplin

normalized age: 470 ± 60
$\delta^{13}C$= -25‰e
uncorrected age: 470 ± 60

Significance: Woodland, Selkirk

A-1324, birch charcoal (7.4 g), *Betula* sp. (id. by A. Long and J.H. McAndrews), from extremely thin stratum just below Selkirk Layer 1a, 85 cm below datum, submitted by M. Tamplin

normalized age: 560 ± 45
$\delta^{13}C$= -25‰e
uncorrected age: 560 ± 45

Note: Listed as a Layer 1b date in A-X, assigned to Layer 1a in Tamplin (1977).

Significance: Woodland, Selkirk

A-1349, charcoal (4.3 g), from pit in Unit 10n10w, ca. 100 cm below datum, assigned to Unit 3 (Layer 1a and 1b), submitted by M. Tamplin

normalized age: 980 ± 150
$\delta^{13}C$= -25‰e
uncorrected age: 980 ± 150

Note: Pit penetrates both Layers 1a and 1b; treated as minimum age for Layer 1b in Tamplin (1977).

Significance: Woodland, Avonlea?, may be limiting date

A-1294, charcoal, from pit in light gray silt, Unit 6n4w, 80 cm below datum, 1.3 m depth, excavated from Layer 1b into deeper layers, submitted by M. Tamplin

normalized age: 1330 ± 100
$\delta^{13}C$= -25‰e
uncorrected age: 1330 ± 100

Significance: Woodland, Avonlea

A-1368, charcoal (5.2 g), from organic, humic silt, top of Layer 2, Unit 10n2w, southwest quad, 1.13 m below datum, immediately beneath a Laurel vessel, submitted by M. Tamplin

normalized age: 1590 ± 50
$\delta^{13}C$= -25‰e
uncorrected age: 1590 ± 50

Significance: Woodland, Laurel

A-1424, charcoal (2 g), from hearth, Unit 6n6w, top of Layer 2, 119 cm below datum, submitted by M. Tamplin

normalized age: 1820 ± 150
$\delta^{13}C$= -25‰e
uncorrected age: 1820 ± 150

Significance: Woodland, Laurel

A-1425, charcoal (4.5 g), from hearth, Unit 6n2w, west half, top of Layer 2, 118 cm below datum, submitted by M. Tamplin

normalized age: <20
$\delta^{13}C$= -25‰e
uncorrected age: <20

Note: Sample was hand-cleaned and pretreated at Trent University, presumably became contaminated by very recent carbon in the process; 23.3 ± 0.9 modern

Significance: Woodland, Laurel, anomalous, young

A-1369, charcoal (5.9 g), from pit in pea gravel, organic silt, Unit 2n8w, Layer 2, 1.14 m below datum, at base of lowest occupation level, submitted by M. Tamplin

normalized age: 3190 ± 60
$\delta^{13}C$= -25‰e
uncorrected age: 3190 ± 60

Significance: Archaic, Duncan

CAMS-13185, human bone collagen, *Homo sapiens*, from burial in clay, collected 1992, submitted by E.L. Syms

normalized age: 1740 ± 60
$\delta^{13}C$= -20.0‰

Significance: Woodland, Laurel

CAMS-13186, human bone collagen, *Homo sapiens*, from burial in clay, collected 1992, submitted by E.L. Syms

normalized age: 1750 ± 60
$\delta^{13}C$= -20.3‰

Significance: Woodland, Laurel

CAMS-13184, human bone collagen, *Homo sapiens*, from burial in clay, collected 1992, submitted by E.L. Syms

normalized age: 1810 ± 60
$\delta^{13}C$= -19.9‰

Significance: Woodland, Laurel

FlMh-1, Carrot River: near The Pas on the south bank of the Saskatchewan River, 267 m asl, west of mouth of the Carrot River, Manitoba (NTS 63 F/14). Sources: A-X; Long and Tamplin, 1977.

A-1196, spruce charcoal (13.26 g), *Picea* sp. (id. by A. Long and J.H. McAndrews), from hearth, Unit 4n10w, Layer A, 1.35 m depth, submitted by M. Tamplin

uncorrected age: 490 ± 110
$\delta^{13}C$= -25‰e
normalized age: 490 ± 110

Significance: Woodland, Selkirk

GdKn-1, Elk Island: on the south shore of Elk Island, 198 m asl, Gods Lake, Manitoba (NTS 53 L/09). It is a stratified site with Shield Archaic below Selkirk focus. Comment by Wright: both dates indicate Elk Island site component is a late example of Shield Archaic. Time between the two readings suggests that the Archaic occupation was of limited duration. Sources: GaK-VIII; Gordon, 1996; Wilmeth, 1978; Wright, 1972.

GaK-1860 (CMC-226), charcoal, from test trench 2, level 2, beneath hearth 1, 10-14 cm depth, collected 1967.08.10, submitted by J.V. Wright

normalized age: 2760 ± 240
$\delta^{13}C$= -25‰e
uncorrected age: 2760 ± 240

Significance: Late Shield Archaic

GaK-1861 (CMC-227), charcoal, from test trench 2, under edge of boulder at 37 cm N, 1.4 m W, 30 cm depth, collected 1967.08.11, submitted by J.V. Wright

normalized age: 2830 ± 210
$\delta^{13}C$= -25‰e
uncorrected age: 2830 ± 210

Significance: Late Shield Archaic

GdKn-3, Gods Lake: on the south shore of Gods Lake at the northeast end of the bay leading to Chataway Lake, Manitoba (NTS 53 L/09). It is stratified, with Selkirk focus and Laurel tradition in superposition above a Shield Archaic component. GaK-1862 should date the Shield Archaic component, but being from the upper portion of the deposit, it may pertain to the Laurel tradition or a Selkirk focus occupation. Comment by Wright: GaK-1862 obviously pertains to Late Woodland Selkirk focus and equates with readings for early portion of this complex from Southern Indian Lake. Sources: GaK-VIII; Wilmeth, 1978; Wright, 1972.

GaK-1862 (CMC-228), charcoal, from test trench 1, section 3, feature 1, 1 m E, 15 cm S, 13 cm depth, collected 1967.08.17, submitted by J.V. Wright

normalized age: 1140 ± 80
$\delta^{13}C$= -25‰e
uncorrected age: 1140 ± 80

Significance: Woodland, unspecified

GjLp-3, Wuskwatim (UNR 48): in a protected section of a large point, 230 m asl, southwest shore of Wuskwatim Lake, Manitoba (NTS 63 O/10). A gun barrel was recovered from the hearth dated by GaK-6057, along with two rim sherds of Clearwater Lake Punctate ware. GaK-6058 appeared to be a peg, sharpened with metal tools and driven into the ground. It was located beneath Feature 75-8, a hearth lens. Considerable disturbance in the site area may have contaminated GaK-6060. Sources: S-X; Dickson, 1976; Nicholson, 1996.

GaK-6057, charcoal (59 g), from humus, Unit 98n58w, SE 1/4, Levels 1, 2, 3, Feature 75-7, 0-6 cm depth, collected 1975.08, submitted by G. Dickson

normalized age: 10 ± 80
$\delta^{13}C$= -25‰e
uncorrected age: 10 ± 80

Significance: Woodland, Clearwater Lake, anomalous, young

GaK-6060, charcoal (8 g), from brown clay-like soil, Unit 96n104w, Level 3, Feature 75-8, 4-8 cm depth, collected 1975.08, submitted by G. Dickson

normalized age: 30 ± 110
$\delta^{13}C$= -25‰e
uncorrected age: 30 ± 110

Significance: Historic

GaK-6058, wood (24.9 g), from lacustrine clay, Unit 96n104w, Levels 3, 4, 5, 4-12 cm depth, collected 1975.08, submitted by G. Dickson

normalized age: 230 ± 80
$\delta^{13}C$= -25‰e
uncorrected age: 230 ± 80

Significance: Protohistoric

S-1076, bone collagen (from 287 g), from humus, light brown clay, Unit 88n116w, NE 1/4, Level 1 & 2, 0-4 cm depth, collected 1975.08, submitted by G. Dickson

normalized age: 550 ± 75
$\delta^{13}C$= -20‰e
uncorrected age: 470 ± 70

Significance: Woodland, Blackduck

S-1080, bone collagen (from 175 g), from nuggety clay, Unit 100n92w, SE 1/4, Level 3, 4-8 cm depth, collected 1975.07, submitted by G. Dickson

normalized age: 570 ± 90
$\delta^{13}C$= -20‰e
uncorrected age: 490 ± 90

Significance: Woodland, Blackduck

GkLr-61, Victoria Day: Threepoint Lake, near Nelson House, ca. 110 km west of Thompson, Nelson drainage, Manitoba (NTS 63 O/15). Sources: E.L. Syms, p.c. 1998.

TO-6031, antler collagen (2070 mg), from Feature 2, a scraper (GkLr-61: 11), submitted by E.L. Syms

normalized age: 3700 ± 60
$\delta^{13}C$= ? ‰

Significance: Archaic, unspecified

TO-6032, loon bone collagen (1300 mg), *Gavia* sp. ulna, from Feature 2 (GkLr-61: 28), submitted by E.L. Syms

normalized age: 3920 ± 60
$\delta^{13}C$= ? ‰

Significance: Archaic, unspecified

CAMS-13188, bone collagen, from Feature 1, a bone harpoon, submitted by E.L. Syms

normalized age: 4050 ± 50
$\delta^{13}C$= -22.1‰

Significance: Archaic, unspecified

CAMS-13187, bone collagen, from Feature 1, a limb bone, submitted by E.L. Syms

normalized age: 4370 ± 60
$\delta^{13}C$= -21.6‰

Significance: Archaic, unspecified

GkLs-1, Wapisu (UNR 26): on a point on the east shore of Wapisu Lake, at Rat River, 244 m asl, about 18 km west of Nelson House, Manitoba (NTS 63 O/14). This is a multicomponent site containing mainly Laurel occupation debris with lesser amounts of late Archaic, Blackduck, and historic material. Due to slope instability, root penetration and trampling, there is considerable vertical admixture of different components, and the Laurel and Blackduck sherds reach their peak frequencies in the same excavation level. Separate activity and occupation loci can be traced horizontally, and the radiocarbon dates can be assigned to occupation components by their associations with cultural features. Tisdale and Jamieson (1982:54-56) provide detailed discussions of radiocarbon sample associations that are reflected in this data base. Sources: S-X; Dickson, 1976; Tisdale and Jamieson, 1982; Wiersum and Tisdale, 1977.

S-957, bone collagen, from greyish brown clay, Unit 90&92n122w, Level 3, Feature 74-11, 8-12 cm depth, collected 1974.08, submitted by W. Wiersum

normalized age: 880 ± 180
$\delta^{13}C$= -20‰e
uncorrected age: 800 ± 180

Note: Sample was small, diluted with dead gas; result is anomalous in relation to S-959 from the same unit.

Significance: Woodland, Blackduck

GaK-6495, charcoal, from Unit 90N120W, Feature 76-1, 16-17 cm depth, collected 1976, submitted by J.M. Jamieson

normalized age: 1090 ± 120
$\delta^{13}C$= -25‰e
uncorrected age: 1090 ± 120

Significance: Woodland, Blackduck

S-959, bone collagen, from hard, block clay, Unit 90n122w, Level 2, 8-10 cm depth, collected 1974.08, submitted by W. Wiersum

normalized age: 1730 ± 200
$\delta^{13}C$= -20‰e
uncorrected age: 1650 ± 200

Note: Sample was small, diluted with dead gas to obtain measurement.

Significance: Woodland, Laurel

S-956, charcoal, from brown silt, Unit 88n122w, Level 2, Feature 74-18, 8 cm depth, collected 1974.08, submitted by W. Wiersum

normalized age: 1920 ± 90
$\delta^{13}C$= -25‰e
uncorrected age: 1920 ± 90

Significance: Woodland, Laurel

S-958, burnt bone collagen, from light clay, Units 92n112w & 94n112w, Level 1, Feature 74-20, 0-5 cm depth, collected 1974.08, submitted by W. Wiersum

normalized age: modern
$\delta^{13}C$= -20‰e
uncorrected age: modern

Note: Sample may have been contaminated or else a recent hearth was superimposed on the Laurel occupation.

Significance: Woodland, Laurel, anomalous, young

GkLt-20, Wapisu Cairn: Wapisu Lake, Churchill drainage, Manitoba (NTS 63 O/14). Sources: E.L. Syms, p.c. 1998.

CAMS-13191, human bone collagen, *Homo sapiens* tooth, from cairn burial, submitted by E.L. Syms

normalized age: 1700 ± 70
$\delta^{13}C$= -19.9‰

Significance: Woodland, Laurel

CAMS-13190, human bone collagen, *Homo sapiens* limb bone, from cairn burial, submitted by E.L. Syms

normalized age: 1720 ± 60
$\delta^{13}C$= -20.0‰

Significance: Woodland, Laurel

CAMS-13189, bone collagen, from cairn burial, an awl, submitted by E.L. Syms

normalized age: 1750 ± 80
$\delta^{13}C$= -21.3‰

Significance: Woodland, Laurel

GlLu-4, Notigi Lake (UNR 23): at the south end of Notigi Lake, near Rat River, 244 m asl, about 34 km northwest of Nelson House, Manitoba (NTS 63 O/14). Sources: S-X; Dickson, 1976; Wiersum and Tisdale, 1977.

S-745, charcoal, from Unit 86n/98w, Level 4, damp sand, 8-11 cm depth, collected 1973, submitted by O.L. Mallory

normalized age: 465 ± 165
$\delta^{13}C$= -25‰e
uncorrected age: 465 ± 165

Significance: Woodland, Laurel, anomalous, young

S-744, charcoal, from Unit 86n/98w, Level 3, moist sand, 8 cm depth, collected 1973, submitted by O.L. Mallory

normalized age: 920 ± 150
$\delta^{13}C$= -25‰e
uncorrected age: 920 ± 150

Significance: Woodland, Laurel

S-746, charcoal, from Unit 114n94w, Level 6, 11 cm depth, collected 1973, submitted by O.L. Mallory

normalized age: 1200 ± 130
$\delta^{13}C$= -25‰e
uncorrected age: 1200 ± 130

Significance: Woodland, Laurel

HcLx-1, Leaf Rapids Portage (SIL 1): at Leaf Rapids Portage, 259 m asl, on the right bank of Churchill River, Manitoba (NTS 64 B/05). Artifact recoveries range from early Archaic to recent Historic, including Duncan/Hanna, Shield Archaic, Besant and Larter projectile points, and Laurel and Clearwater Lake pottery. No cultural material was associated with GaK-6056, although Archaic artifacts were found in Area A. Kroker (1990: 60) notes that "The faunal remains recovered are probably associated with more recent occupations, due to the deleterious effects of forest fires and humic acids in the soils. The utilized species are moose, bear, beaver, fisher, loon, duck and pike." Sources: Dickson, 1976; Kroker, 1990.

GaK-6056, wood fragments (9.0 g), from between C horizon clays, Area A, Unit 30n38e, Level 5, Feature 1, 20 cm depth, collected 1975.07, submitted by G. Dickson

normalized age: 160 ± 90
$\delta^{13}C$= -25‰e
uncorrected age: 160 ± 90

Significance: Cultural affiliation unknown

HcLx-2, SIL 2: at Leaf Rapids Portage, 259 m asl, on a small point directly east of SIL 1, right bank of Churchill River, Manitoba (NTS 64 B/05). Sources: Dickson, 1976.

GaK-6059, charred wood (18 g), from damp sand and clay, hearth in test pit, 5-12 cm depth, collected 1975.08, submitted by G. Dickson

normalized age: 0 ± 80
$\delta^{13}C$= -25‰e
uncorrected age: 0 ± 80

Note: The sample is considered to have been contaminated.

Significance: Woodland, Clearwater Lake, anomalous, young

HeLw-1, MacBride: on the east side of the mouth of MacBride River, where it enters Barrington River, 259 m asl, west of Opachuanau Lake, Manitoba (NTS 64 B/13). European trade items were found in direct association with Selkirk ceramics, stone and bone tools. GaK-1255 is too late to pertain to the sample, but GaK-1267 is acceptable in as much as it indicates the lateness of the deposits and therefore reinforces the apparent association of European and aboriginal artifacts. Sources: GaK-VII; Wilmeth, 1978; Wright, 1971.

GaK-1267 (CMC-178), charcoal, from test trench 2, southern half, 5-10 cm depth, collected 1966.07.27, submitted by J.V. Wright

normalized age:	360 ± 100
	$\delta^{13}C$= -25‰e
uncorrected age:	360 ± 100

Significance: Woodland, Selkirk

GaK-1255 (CMC-177), charcoal, from test trench 1, northwest corner, 5-13 cm depth, collected 1966.07.27, submitted by J.V. Wright

normalized age:	<150
	$\delta^{13}C$= -25‰e
uncorrected age:	<150

Significance: Woodland, Selkirk, anomalous, young

HeLw-20, Flicker (SIL 257): on the left bank of MacBride River, 400 m south of the lower rapids, 800 m north of the river mouth, at western end of Southern Indian Lake, Manitoba (NTS 64 B/13). The site is 1.6 km north of Wright's MacBride site (HeLw-1). The site surface was littered with recent Historic material that extended into the first 5 cm of the humus and moss. Fur Trade period material was also present. Prehistoric artifacts include Plains and Prairie side-notched points and Clearwater Lake pottery. "As there was no evidence of stratigraphy, it was impossible to determine the context and/or association of any of the non-diagnostic artifacts" (Kroker, 1990: 70). Sources: S-X; Dickson, 1976; Kroker, 1990.

S-781, charcoal, from hearth at contact of moss-humus and clay, 8 cm depth, collected 1973.07, submitted by M. Hanna

normalized age:	460 ± 100
	$\delta^{13}C$= -25‰e
uncorrected age:	460 ± 100

Significance: Woodland, Clearwater Lake

HfLp-11, Fire Island (SIL 184): on an island in Sandhill Bay, 259 m asl, along eastern shore of Southern Indian Lake, Manitoba (NTS 64 B/15). S-965 was associated with a Clearwater Lake pottery vessel. Sources: S-X; Dickson, 1976.

S-965, burnt and unburnt bone collagen, from clay matrix, unit 1, Level 1, 0-3 cm depth, collected 1974.08, submitted by M. Kelly

normalized age:	380 ± 170
	$\delta^{13}C$= -20‰e
uncorrected age:	300 ± 170

Note: Sample required dilution with dead gas to obtain a measurement.

Significance: Woodland, Clearwater Lake

HfLq-1, Neck: on the north portion of a long neck connecting a large island to the mainland, 259 m asl, eastern side of Southern Indian Lake, 26 km northeast of South Indian Post, Manitoba (NTS 64 B/15). This is a two-component Selkirk focus site.

Wilmeth (1978: 112) provides a summary comment: Wright points out that each of the two sets of dates agrees with the stratigraphic sequence. The I-2082 determination, which agrees with I-2080 and I-2081, indicates that the thin lens is not significantly earlier than the rest of stratum II. However, the Gakushuin dates are consistently earlier than those from Isotopes. On the basis of what is known of Selkirk focus time depths, Wright tends to favour the Isotopes readings. Sources: GaK-VII, I-VI; Wilmeth, 1978; Wright, 1971.

I-2078 (CMC-70), charcoal, from trench 2, southwest portion, stratum 1, 25 cm depth, collected 1965.07, submitted by J.V. Wright

normalized age:	435 ± 110
	$\delta^{13}C$= -25‰e
uncorrected age:	435 ± 110

Significance: Woodland, Selkirk

GaK-1259 (CMC-173), charcoal, from square A, stratum 1, 33 cm depth, directly under flooring of pot sherds, collected 1966.07.15, submitted by J.V. Wright

normalized age:	760 ± 80
	$\delta^{13}C$= -25‰e
uncorrected age:	760 ± 80

Significance: Woodland, Selkirk

I-2082 (CMC-74), charcoal, from trench 2, stratum 2', thin lens diverging from bottom of stratum 2, 88 cm depth, collected 1965.07, submitted by J.V. Wright

normalized age:	705 ± 320
	$\delta^{13}C$= -25‰e
uncorrected age:	705 ± 320

Significance: Woodland, Selkirk

I-2081 (CMC-73), charcoal, from trench 1, northeast quadrant, stratum 2, 23-28 cm depth, collected 1965.07, submitted by J.V. Wright

normalized age:	730 ± 150
	$\delta^{13}C$= -25‰e
uncorrected age:	730 ± 150

Significance: Woodland, Selkirk

GaK-1260 (CMC-174), charcoal, from test trench 3, east half, stratum 2, 16-23 cm depth, collected 1966.07.18, submitted by J.V. Wright

normalized age:	1190 ± 70
	$\delta^{13}C$= -25‰e
uncorrected age:	1190 ± 70

Significance: Woodland, Selkirk

I-2080 (CMC-72), charcoal, from trench 2, stratum 2, 35 cm depth, collected 1965.07, submitted by J.V. Wright

normalized age:	<1210
	$\delta^{13}C$= -25‰e
uncorrected age:	<1210

Significance: Woodland, Selkirk

HgLo-1, Long Point: on the south-facing mid-point of Long Point, 259 m asl, 42 km northeast of South Indian Post, Southern Indian Lake, Manitoba (NTS 64 G/01). This is a non-ceramic site with stratified sections resulting from storm beach action. Very little was recovered in terms of significant artifacts. The two dates are consistent with the stratigraphy and parallel dates from the stratified

Neck site (HfLq-1). They support the proposal that the site is non-pottery rather than pre-pottery. Sources: GaK-VII; Wilmeth, 1978; Wright, 1971.

GaK-1261 (CMC-175), charcoal, from test trench 2, stratum 1, beneath 15-20 cm of sterile sand and gravel, collected 1966.07.11, submitted by J.V. Wright

normalized age: 930 ± 80
$\delta^{13}C$= -25‰e
uncorrected age: 930 ± 80

Significance: Cultural affiliation unknown

GaK-1262 (CMC-176), charcoal, from test trench 2, second duff line, 78-86 cm depth, collected 1966.07.11, submitted by J.V. Wright

normalized age: 1000 ± 80
$\delta^{13}C$= -25‰e
uncorrected age: 1000 ± 80

Significance: Cultural affiliation unknown

HgLt-1, Nagami Bay: on Southern Indian Lake, Churchill drainage, Manitoba (NTS 64 G/03). According to Syms, all of the bone dates from this protohistoric site are unacceptably early, but Beta-106475 on plant seeds gives the expected age. Sources: Brownlee and Syms, 1999.

Beta-106475 (AMS Kiel), plant seeds, from cultural layer, submitted by E.L. Syms

normalized age: 220 ± 50
$\delta^{13}C$= -25.3‰
uncorrected age: 220 ± 50

Significance: Protohistoric

Beta-107745 (AMS Oxford), human bone collagen, *Homo sapiens*, from cultural layer, submitted by E.L. Syms

normalized age: 440 ± 30
$\delta^{13}C$= -23.3‰
uncorrected age: 420 ± 30

Significance: Protohistoric, anomalous, old

TO-5228, human bone collagen, *Homo sapiens* radius (2400 mg), from cultural layer, submitted by E.L. Syms

normalized age: 590 ± 40
$\delta^{13}C$= ? ‰

Note: A re-analysis using a very extensive collagen extraction corroborated this result: TO-5228a, 570 ± 50 BP.

Significance: Protohistoric, anomalous, old

HhLp-16: on Southern Indian Lake, Churchill drainage, Manitoba (NTS 64 G/07). Sources: E.L. Syms, p.c. 1998.

TO-5229, antler collagen, from cultural layer, a leister prong, submitted by E.L. Syms

normalized age: 3600 ± 60
$\delta^{13}C$= ? ‰

Significance: Cultural affiliation unknown

HiLp-1, Kame Hills: at the northwestern corner of Southern Indian Lake, 259 m asl, near the mouth of Muskwesi River, Manitoba (NTS 64 G/07). This is a large multicomponent habitation site with evidence of Archaic, Taltheilei, Woodland (Laurel and Clearwater Lake), and Historic occupations occurring in a sand matrix up to 25 cm in thickness. Except for specific field observations of faunal associations with radiocarbon samples reported by Dickson (1976) and recorded in this data base, it is not possible to determine the faunal assemblage that belongs to a particular period of occupation. GaK-6061 is considered anomalous in view of its depth and an earlier result from GaK-6064. Nothing was directly associated with GaK-6067, but it gives a maximum age for Laurel pottery found just above it. S-778 is considered too young for its depth and associations; this result may be related in part to the pre-treatment method. S-968 was possibly contaminated by a fungus growing beneath some of the bones. S-1077 was surrounded by water due to an unusually high water table. S-1078 was within and beneath hearth Feature 2-75; the result is rejected by Dickson. Sources: S-X; Dickson, 1976, 1980; Gordon, 1996.

S-968, burnt beaver and porcupine bone collagen, *Castor canadensis* and *Erethizon dorsatum* (339.5 g, id. by L. Roberts), from ash, sand, moss, Unit 479, Levels 1-2, Feature 19-73, 0-10 cm depth, collected 1973.08, submitted by G. Dickson

normalized age: 170 ± 55
$\delta^{13}C$= -20‰e
uncorrected age: 90 ± 50

Significance: Woodland, Clearwater Lake, anomalous, young

GaK-6061, charcoal (13.3 g), from damp sand, Units 505 and 510, Level 2, Feature 1-75, 6-9 cm depth, collected 1975.07, submitted by G. Dickson

normalized age: 210 ± 130
$\delta^{13}C$= -25‰e
uncorrected age: 210 ± 130

Significance: Woodland, Clearwater Lake, anomalous, young

S-1078, charcoal (15.5 g), from damp sand, Units 515 and 520, Level 2, Feature 2-75, 3-8 cm depth, collected 1975.07, submitted by G. Dickson

normalized age: 240 ± 65
$\delta^{13}C$= -25‰e
uncorrected age: 240 ± 65

Significance: Woodland, Clearwater Lake

GaK-6066, charcoal (13.2 g), from sand and ash, Test Pit 2, Level 2, Feature 5-75, 1-10 cm depth, collected 1975.07, submitted by G. Dickson

normalized age: 340 ± 90
$\delta^{13}C$= -25‰e
uncorrected age: 340 ± 90

Significance: Woodland, Clearwater Lake

GaK-6062, charcoal (7.6 g), from damp sand, Units 515 and 520, Level 2, Feature 2-75 periphery, 0-2 cm depth, collected 1975.06, submitted by G. Dickson

normalized age: 380 ± 70
$\delta^{13}C$= -25‰e
uncorrected age: 380 ± 70

Significance: Woodland, Clearwater Lake

GaK-6064, charcoal (8.4 g), from damp sand, Units 509 and 510, Level 2, Feature 3-75, 1-9 cm depth, collected 1975.07, submitted by G. Dickson

normalized age: 620 ± 100
$\delta^{13}C$= -25‰e
uncorrected age: 620 ± 100

Significance: Woodland, Clearwater Lake

GaK-6065, charcoal (8.9 g), from damp sand, Units 524 and 429, Level 2, Feature 4-75, 1-10 cm depth, collected 1975.07, submitted by G. Dickson

normalized age: 650 ± 100
$\delta^{13}C$= -25‰e
uncorrected age: 650 ± 100

Significance: Woodland, Clearwater Lake

S-966, charcoal (12.2 g), from sand, Units 455 and 550, Level 2, hearth Feature 3-74 periphery, 5-6 cm depth, collected 1974.06, submitted by G. Dickson

normalized age: 1010 ± 100
$\delta^{13}C$= -25‰e
uncorrected age: 1010 ± 100

Significance: Woodland, Clearwater Lake

S-778, burnt bone collagen, from sand, Unit 287, Level 3, 20 cm depth, collected 1973.07, submitted by G. Dickson

normalized age: 1060 ± 140
$\delta^{13}C$= -20‰e
uncorrected age: 980 ± 140

Significance: Cultural affiliation unknown

GaK-6063, charcoal (7.8 g), from damp sand, Units 515 and 520, Level 2, hearth Feature 2-75, 1-6 cm depth, collected 1975.07, submitted by G. Dickson

normalized age: 1290 ± 150
$\delta^{13}C$= -25‰e
uncorrected age: 1290 ± 150

Significance: Woodland, Laurel

GaK-6067, charcoal (6.9 g), from dry sand, Unit 476, Level 3, Feature 16-73, 15 cm depth, collected 1973.08, submitted by G. Dickson

normalized age: 1890 ± 90
$\delta^{13}C$= -25‰e
uncorrected age: 1890 ± 90

Significance: Woodland, Laurel maximum

S-779, charcoal, from sand, Unit 353, Level 5, Feature 14-73, 38 cm depth, collected 1973.08, submitted by G. Dickson

normalized age: 2700 ± 600
$\delta^{13}C$= -25‰e
uncorrected age: 2700 ± 600

Note: The large error is due to low carbon yield, diluted with dead gas to obtain measurement.

Significance: Late Shield Archaic

S-780, charcoal, from sand matrix, Units 353 and 358, Level 5, Feature 10-73, 35-40 cm depth, collected 1973.08, submitted by G. Dickson

normalized age: 3170 ± 70
$\delta^{13}C$= -25‰e
uncorrected age: 3170 ± 70

Significance: Late Shield Archaic

S-967, charcoal (9.4 g), from sand matrix, Units 554 and 559, Level 3, 15-20 cm depth, collected 1974.07, submitted by G. Dickson

normalized age: 3340 ± 65
$\delta^{13}C$= -25‰e
uncorrected age: 3340 ± 65

Significance: Late Shield Archaic

S-1077, bison bone collagen, *Bison* sp. (110.64 g), from sand-humus matrix, test pit 5, Level 4, 25 cm depth, collected 1974.08, submitted by G. Dickson

normalized age: 3590 ± 90
$\delta^{13}C$= -20‰e
uncorrected age: 3510 ± 90

Significance: Cultural affiliation unknown

IeKn-6, Seahorse Gully: on a quartzite ridge, 35 m high, 29-35 m asl, along the east shore of Button Bay, on the west side of the mouth of Churchill River, across from Churchill, Manitoba (NTS 54 L/09). It contains Pre-Dorset and Dorset components. S-521 should date the most southerly extension of Pre-Dorset culture along west coast of Hudson Bay area. S-738 provides a limiting age on the Pre-Dorset occupation as it indicates when Hudson Bay waters were 35 m above present level (Andrews et al., 1971). I-3973 pertains to the Dorset component. Sources: S-VI, S-VII; Meyer, 1977; Nash, 1969, 1972; Wilmeth, 1978.

I-3973, charcoal, from hearth in house 3, submitted by R.J. Nash

normalized age: 2080 ± 95
$\delta^{13}C$= -25‰e
uncorrected age: 2080 ± 95

Significance: Palaeoeskimo, Dorset

S-521, ringed seal bone collagen, *Phoca hispida*, from House 5, Level 1, between hearth and east side of dwelling, collected 1968, submitted by D. Meyer

normalized age: 3060 ± 100
$\delta^{13}C$= -15‰e
uncorrected age: 2900 ± 100

Significance: Palaeoeskimo, Predorset

S-738 (CMC-395), marine shells, from below occupations of pre-Dorset dwellings, 10.1-15.2 cm depth, collected 1968, submitted by D. Meyer

normalized age: 3970 ± 125
$\delta^{13}C$= -0‰e
uncorrected age: 3560 ± 105

Significance: Geoarchaeology, below Predorset

IfKs-1, Thyazzi: on the left bank of the North Knife River near the first large bend above its mouth, 24 km inland from Hudson Bay, 48 km northwest of Churchill, Manitoba (NTS 54 L/14). Nash (p.c. 1998) recalled that the sample was analyzed by Teledyne Isotopes, but he could not supply the laboratory number. Sources: Nash, 1969, 1970.

I-n/a-1, charcoal, from hearth, Feature 2, collected 1965, submitted by R.J. Nash

normalized age:	2630 ± 90
	$\delta^{13}C$= -25‰e
uncorrected age:	2630 ± 90

Significance: Palaeoeskimo, Predorset

IeLk-4, Shethanei Narrows: at the tip of an esker on the north side of Shethanei Narrows, in the Seal River valley, northern Manitoba (NTS 64 I/13). A thin occupation layer contains medium-size stemmed, notched and triangular points. A few historic items are mixed with upper prehistoric artifacts, suggesting a late prehistoric occupation. GaK-2341 will date an associated stemmed point.

Comment by Nash: GaK-2341, and I-4149 from another part of the site, indicate that the materials are probably all late whether or not more than one component is involved. Materials are not easily equated with other late complexes in transitional forest which might also relate to Chipewyan. Nash (1975: 22) concludes that the two dates indicate the site's time depth is at least 700 years. GaK-2341 may approximate the beginning of occupation "and could also date the stemmed point from the same pit, even though the point was in the bottom of the sod layer. The 550 year difference between 2 samples which are so close stratigraphically is puzzling, but seems to add support to the suggestion that 2 prehistoric components are involved." Nash also indicates that the identified faunal remains are more closely associated with the later date than with the earlier one. Sources: GaK-VIII; Gordon, 1996; Nash, 1970, 1975; Wilmeth, 1978.

I-4149, charcoal, from bottom of the sod layer, eastern end of the site, submitted by R.J. Nash

normalized age:	220 ± 95
	$\delta^{13}C$= -25‰e
uncorrected age:	220 ± 95

Significance: Late Taltheilei

GaK-2341 (CMC-299), charcoal, from level 2, pit 137e2n, top of grey sand layer near center of site, collected 1967.08, submitted by R.J. Nash

normalized age:	770 ± 80
	$\delta^{13}C$= -25‰e
uncorrected age:	770 ± 80

Significance: Late Taltheilei

IgLx-1, Egenolf Lake: on the spur of an esker on the northeast shore of Egenolf Lake, Manitoba (NTS 64 O/04). The site consists of a deeply buried occupation layer with several hearths and considerable bone and scrapers. Although not in situ, a small side-notched point was probably associated. GaK-2342 will date the site and the side-notched point. The complex may be related to the historic Chipewyan of the area.

Comment by Nash: the date seems somewhat late in view of 25-50 cm of sand overlying the occupation layer, but it is compatible with the small side-notched point. The artifacts contribute to the heterogeneity of the late transitional forest occupations perhaps attributable to Chipewyan. Heterogeneity may be the result of seasonal, functional or historical factors. Nash (1975: 31-33) concluded that the occupation probably represents the winter season. Sources: GaK-VIII; Gordon, 1996; Nash, 1970, 1975; Wilmeth, 1978.

GaK-2342 (CMC-300), charcoal, from occupation layer of pit 9, beneath 25-50 cm of sand, collected 1967, submitted by R.J. Nash

normalized age:	460 ± 80
	$\delta^{13}C$= -25‰e
uncorrected age:	460 ± 80

Significance: Late Taltheilei

IhLa-1, Caribou Hill: on a morainic hill, 25-30 feet above Caribou Lake, about 800 m from the lake, Caribou drainage, northern Manitoba (NTS 64 P/08). Sources: Gordon, 1996; Nash, 1975.

I-6000, charcoal, from cultural layer, submitted by R.J. Nash

normalized age:	775 ± 90
	$\delta^{13}C$= -25‰e
uncorrected age:	775 ± 90

Significance: Late Taltheilei

IiLk-1, Duck Lake Narrows: at a narrows between Little Duck Lake and Nejanilini Lake, 56 km south of the Keewatin border, north-central Manitoba (NTS 64 P/05). Sources: Gordon, 1996; Nash, 1970.

I-3032, charcoal, from near the bottom of an occupation layer, submitted by R.J. Nash

normalized age:	990 ± 110
	$\delta^{13}C$= -25‰e
uncorrected age:	990 ± 110

Significance: Late Taltheilei

I-3033, charcoal, from near the bottom of an occupation layer, submitted by R.J. Nash

normalized age:	1290 ± 110
	$\delta^{13}C$= -25‰e
uncorrected age:	1290 ± 110

Significance: Late Taltheilei

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